

SECTION 401 PORTLAND CEMENT CONCRETE PAVEMENT:

401-1 Description:

The work under this section shall consist of furnishing all materials and constructing a pavement surface using Portland cement concrete and shall include coring operations, furnishing and placing dowels and tie bars, furnishing and placing miscellaneous reinforcing steel and joint materials, and constructing joints in accordance with the details shown on the plans and the requirements of these specifications.

The contractor shall proportion, mix, place, finish, and cure concrete in accordance with the requirements of these specifications.

401-2 Materials:

Portland cement concrete for pavement shall consist of a mixture of hydraulic cement, fine aggregate, coarse aggregate, water, and admixtures.

Unless otherwise provided, Portland cement concrete pavement shall conform to the requirements of Section 1006. Concrete shall be Class P.

Materials for expansion joint filler and joint seal shall conform to the requirements of Section 1011 unless otherwise shown on the project plans or specified in the Special Provisions.

Materials for tie bars and dowel bars shall conform to the requirements of Section 1003. Materials for dowel bars shall conform to the requirements of AASHTO M 254 with Type B coating except that the core material shall conform to the requirements of ASTM A 615, Grade 40. When epoxy coated reinforcing steel is designated, it shall conform to the requirements of Subsection 1003-5.

Liquid membrane curing compound shall conform to the requirements of Subsection 1006-2.05.

401-3 Construction Requirements:

401-3.01 General:

At least 20 days prior to paving, the contractor shall furnish the following information for the Engineer's review for specification compliance:

A detailed sequence and schedule of concrete placement operations including, but not necessarily limited to; width of pavement to be placed, proposed equipment, production rates, working hours, concrete hauling, placement methods, curing, sawing and sealing methods.

A detailed staking plan for subgrade controls including offset requirements.

A traffic control plan for pavement construction operations which includes provisions for the placement and maintenance of barriers required to protect the pavement from traffic for a minimum of seven days after concrete placement.

Mainline concrete pavement shall be constructed with slip-form paving equipment; however, areas inaccessible to slip-form paving equipment may be constructed with fixed side forms. Ramps and irregular pavement areas shall be constructed with either slip-form paving equipment or fixed side forms.

Unless otherwise shown on the plans, the main roadway, including concrete shoulders or distress lanes, shall be placed in a single monolithic pass, provided the finished surface of the pavement consistently conforms to the requirements for grade, alignment and pavement smoothness as specified herein. Paving widths which are less than the full main roadway width shall be constructed with longitudinal construction joints that are located on the lane line or at the edge of the main roadway.

The contractor may submit an alternate paving plan for review by the Engineer. The alternate plan shall be submitted in writing at least 45 days prior to paving and the Engineer's approval shall be obtained prior to proceeding with alternate paving methods.

401-3.02 Pavement Base:

The surface of lean concrete base, cement treated base, or subgrade upon which the concrete pavement is to be placed shall conform to the finish and elevation requirements specified for the material involved. The surface shall be free of all loose and extraneous material and the surface shall be uniformly moistened immediately prior to placing concrete when the ambient temperature is greater than 85 degrees F as verified with a Department-furnished calibrated thermometer.

When Portland cement concrete pavement is constructed over lean concrete base, curing compound shall be applied to the surface of the lean concrete base at a rate of not less than one gallon per 150 square feet. The curing compound shall be Type 2 with a Class A vehicle conforming to the requirements of Subsection 1006-2.05 and the nonvolatile portion of the Class A vehicle shall contain natural or petroleum waxes. This curing compound shall be placed in addition to curing compound placed as part of lean concrete base construction and shall be applied no more than 24 hours prior to placement of Portland cement concrete pavement. The curing compound shall be allowed to set-up prior to placement of Portland cement concrete pavement.

Curing compound may be applied after placement of required load transfer dowel assemblies however, uniform coverage with curing compound must be achieved under the dowel assemblies and spot spraying or additional applications of curing compound may be required to achieve uniform coverage. If load transfer dowel assemblies are placed after application of curing compound, the curing compound shall be allowed to set-up prior to dowel placement. Curing compound membrane which is damaged during placement of load transfer dowel assemblies or during other operations shall be repaired with a reapplication of curing compound prior to placement of Portland cement concrete pavement.

Portland cement concrete pavement shall not be placed over lean concrete base or cement treated base for at least 7 days after placement of the lean concrete base or cement treated base unless otherwise approved by the Engineer.

401-3.03 Forming:

(A) General:

Unless the project requires contractor surveying, the Engineer will place one stake for elevation control and alignment on each side of the roadway at 50-foot intervals and at grade breaks in accordance with the contractor's staking plan. The contractor shall make any additional projections necessary to establish line and grade.

If the project requires surveying by the contractor, the contractor shall place stakes for elevation control and alignment as specified above, or as approved by the Engineer.

(B) Slip-Form Method:

The contractor shall set taut guide lines to control both line and grade.

Slip-form equipment shall be equipped with automatic sensing and control devices and shall operate such that the machine automatically follows the guide line.

Slip-form paving equipment shall be equipped with traveling side forms designed to laterally support the concrete for a length of time which is sufficient to produce pavement of the required cross section.

No abrupt changes in longitudinal alignment of the pavement will be permitted. The horizontal deviation from the alignment shown on the plans shall not exceed 0.10 feet.

(C) Fixed Form-Manual Method:

Forms shall be set to the required lines and grades well in advance of placing concrete and shall be as approved by the Engineer prior to concrete placement.

Forms shall be made of steel and have an approved section with a base width of at least four inches and a depth equal to or greater than the thickness of the pavement. The forms shall be staked with steel stakes of appropriate lengths. Each form section shall have a stake pocket at each end and at intervals of not more than five feet. The stake pockets shall have a device for locking the form to the steel stakes. Each form section shall be straight and free of bends and warps at all times. The top of each form section shall not vary from a true plane by more than 1/8 inch in 10 feet and the inside face shall not vary more than 1/4 inch in 10 feet.

Wood or other rigid forms may be used in irregular areas as approved by the Engineer.

Forms shall be thoroughly cleaned and oiled each time they are used.

Before forms are placed, the underlying material shall be finished to the required grade and shall be firm and smooth. The forms shall be uniformly supported upon the subgrade or base and shall be placed to the required grade and alignment. Forms shall be supported so that they will not deviate more than 1/8 inch from the proper elevation during paving operations.

Forms shall remain in place until the day after placing the concrete and shall be removed in a manner that will prevent damage to the pavement. Pry bars shall not be used between the forms and the pavement under any circumstances.

401-3.04 Placing and Finishing:

(A) General:

When daytime ambient temperatures are expected to exceed 100 degrees F and when directed by the Engineer, concrete shall be placed only between the hours of 8:00 p.m. and 8:00 a.m.

Immediately prior to placing concrete, the contractor shall verify that the elevations of guide wires controlling slip-form pavers and the elevations of fixed forms are such that the thickness and finished grade of the pavement will be in accordance with the requirements of the project plans and these specifications.

Concrete shall be placed using methods that result in a minimum of handling and segregation and in a manner that will result in the concrete being distributed uniformly across the front of the paving machine.

Concrete placement shall be continuous between expansion or construction joints. The concrete shall be struck off, consolidated and floated by mechanical methods. The contractor may, with the approval of the Engineer, use a free floating, oscillating screed device, which is a minimum of 10 feet in length and attached to the paver, in conjunction with or in lieu of tubular floats. When pavement widths are less than 10 feet and where it is impractical to use mechanical methods, manual methods may be used to finish the concrete surface.

If surface drying or cracking should occur prior to the application of curing material, the entire surface of the concrete shall be kept damp by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The water from the nozzle shall not be applied directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

The contractor shall protect the base or subgrade when equipment is cleaned at the end of each days production. All concrete deposited on the base or subgrade during the cleaning operation shall be removed from the base or subgrade immediately after cleaning is completed. Any damage to the base or subgrade, shall be repaired, as approved by the Engineer, prior to commencing paving operations. Water will not be permitted to pond on the roadway.

Any concrete which is spilled, splattered, or scattered on existing pavement shall be removed before the end of each day's paving operations.

It is important in the performance of the work and in the operation of equipment that no work shall lag and all operations shall be completed within the optimum or specified time; therefore, the Engineer may order the work suspended, if necessary, to maintain proper balance of operations so as to insure satisfactory results.

(B) Slip-Form Method:

The equipment shall spread, consolidate, screed and float-finish the concrete so that a minimum of hand finishing will be necessary and a well consolidated and homogeneous pavement is produced. Additional labor and equipment shall be supplied when paving beyond the limits of the side forms is required.

The machine shall vibrate the concrete for the full width and depth of the concrete. Such vibration shall be accomplished with vibrating tubes or arms working in the concrete and spaced not more than 24 inches center-to-center. Vibrators shall operate at a minimum of 8,000 impulses per minute. Concrete placement shall cease immediately if a vibrator fails to function and cannot be immediately repaired, replaced, or supplemented with additional vibrators.

The machine shall be operated with as nearly a continuous forward movement as possible and all mixing, delivering, and concrete spreading operations shall be coordinated to provide uniform progress. If for any reason it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped simultaneously.

Pavement edge slump in excess of 0.02 feet, exclusive of edge rounding, shall be corrected. If correction is not possible while the concrete is plastic, pavement with excessive edge slump shall be corrected by one of the following methods:

- (1) The pavement shall be removed by saw-cutting a distance not greater than one foot from the pavement edge between adjacent transverse joints. Tie bars shall be placed as specified in Subsection 401-3.05 and the pavement shall be replaced as part of adjacent Portland cement pavement construction.
- (2) If excessive edge slump can not be corrected by method one (1) above, then the pavement shall be removed for the full lane width between adjacent transverse joints and replaced as specified in Subsection 401-4.03(C).

When concrete is being placed adjacent to previously constructed pavement, work bridges for placing and finishing the pavement and the tracks on one side of the paver may be allowed on the new pavement provided that:

- (1) The previously placed pavement has been placed for a minimum of 72 hours.

- (2) Pressure exerted on the pavement by the paver shall not exceed 20 pounds per square inch.
- (3) Tracks on the paver shall be equipped with protective pads, or the surface of the existing pavement shall be protected so that the surface is not damaged.
- (4) No part of the track shall be operated within one foot of the edge of the existing pavement.

Any pavement which is damaged by the contractor's equipment shall be repaired as approved by the Engineer and at no additional cost to the Department.

With the exception of saws used for the construction of weakened plane joints, no other contractor's equipment will be allowed on the pavement until all the requirements specified herein have been met.

(C) Fixed Form Method:

Three types of self-propelled mechanical equipment: the spreader, the finisher, and the float will be required; however, a single machine combining two or more of these operations may be used if it has been demonstrated that such a machine will accomplish satisfactory results. All wheels of all machines that ride on finished concrete surfaces shall be equipped with rubber tires.

The concrete shall be spread uniformly between the forms, immediately after it is placed, by means of the spreading machine. The spreader shall be followed by the finishing machine equipped with not less than two oscillating or reciprocating screeds. The spreading machine or the finishing machine shall be equipped with vibrating equipment that will vibrate the concrete for the full paving width. Vibrators shall be used adjacent to the longitudinal edge of the pavement. These vibrators shall be attached to the rear of the spreading machine or to the finishing machine. Vibrators shall not rest on new pavements or side forms or contact any tie bars, and power to the vibrators shall be such that when the motion of the machine is stopped, vibration will cease. Vibrators shall operate at a minimum of 8000 impulses per minute.

The concrete shall be spread full width before being struck off by the finishing machine. The concrete shall be struck off and consolidated so that the surface will conform to the finished grade and cross section shown on the project plans and at the same time leave sufficient material for the floating operation. The spreading or finishing machine shall move over the pavement as many times and at such intervals as may be required to insure thorough consolidation.

After the pavement has been struck off and consolidated, it shall be floated with an approved longitudinal float.

The contractor may use a longitudinal float composed of one or more cutting and smoothing floats, suspended from and guided by a rigid frame. The frame shall be carried by four or more wheels riding on, and constantly in contact with, the forms.

The contractor may use a longitudinal float which is worked with a sawing motion while being held in a floating position parallel to the roadway centerline and while passing gradually from one side of the pavement to the other. Movements ahead along the centerline of the roadway shall be in successive advances of not more than one half the length of the float.

In lieu of using either type of longitudinal float, a single machine which will effect satisfactory consolidating, finishing and floating may be used. This machine may be towed by a spreading machine. This combination finishing-floating machine shall be equipped with screeds and vibrators as hereinbefore specified for finishing machines. Floating shall be accomplished with a non-oscillating float held in a suspended position from the frame.

If any spreading, finishing and floating equipment is not maintained in full working order or if the equipment used by the contractor proves inadequate to obtain results prescribed, such equipment shall be improved or satisfactory equipment substituted or added.

(D) Fixed Form-Manual Methods:

Manual methods may be permitted by the Engineer in areas inaccessible to mechanical equipment.

When manual methods are permitted, concrete shall be deposited, spread and struck off to such an elevation that, when properly consolidated, the surface will conform to the required lines and grades. The strike board shall be moved forward with a combined longitudinal and transverse motion so that neither end is raised from the side forms. While striking off, a slight excess of concrete shall be kept in front of the cutting edge at all times.

The concrete shall be consolidated by internal vibration. Vibrators shall operate at a minimum of 8000 impulses per minute. Use of vibrators for shifting of the concrete mass will not be permitted.

After consolidation, the concrete shall be tamped to the proper surface elevation and cross section with an approved tamping or screeding device or with a mechanical vibrating unit spanning the full width between forms. A small surplus of concrete shall be kept in front of the tamper or vibrating unit. Tamping or vibrating shall continue until the required cross section is obtained and the mortar is flushed slightly to the surface.

Other approved methods may be used to finish the concrete.

On grades in excess of five percent, a second strike board shall follow behind the tamper or vibrating unit and shall be used in the same manner as the tamper to remove waves caused by the flow of concrete.

(E) Joint Finishing and Edging:

The pavement edges and joints shall be edged in accordance with the details shown on the plans.

(F) Surface Texturing:

Surface Texturing of the plastic concrete shall begin immediately after placement and finishing of the concrete. All excessive surface water shall be dispersed prior to commencing texturing operations. Texturing shall be performed by applying a longitudinal burlap drag followed by transverse texturing using steel tines.

Burlap and steel tines shall be supported by rolling mechanical bridges. They shall not be supported manually except in areas inaccessible to the bridges.

Rolling mechanical bridges supporting steel tines shall be equipped and shall operate with automatic sensing and control devices which follow the same control line as the slip form paver. This machine shall be used for texturing the pavement only. Burlap shall not be supported on the same rolling mechanical bridge used to support the steel tines.

Burlap shall be in accordance with AASHTO M 182, Class 3 and shall traverse the full width of the pavement to within 12 inches of the pavement edge.

The timing of the texturing operations is critical. Grooves that close following texturing will not be permitted and texturing shall be completed before the surface will be torn or unduly roughened by the texturing operation.

Hand tine brooms shall be provided and available at the job site at all times.

Tine texturing shall be performed so that the grooves produced will be uniform. Texture shall be normal to the center line of the roadway and shall extend over the entire roadway width to within three inches of the pavement edge. Swerving groove patterns will not be permitted.

Texture grooves shall be 1/16 to 1/8 inch in width and 3/32 to 7/32 inch in depth. The textured groove depth will be measured in accordance with the requirements of Arizona Test Method 310. The center-to-center spacing of the grooves shall be 1/2 to one inch.

If necessary, hardened concrete shall be textured by any method that will produce the required grooves.

(G) Curing:

Curing compound shall be applied to the concrete within 15 minutes after surface texturing operations and before any drying shrinkage or craze cracks begin to appear. In the event of surface drying or cracking, application of water with an atomizing nozzle shall be started immediately and shall be continued until application of curing material is begun or resumed; however, curing compound shall not be applied over any resulting free standing water.

Liquid curing compound shall be applied in one or more applications totaling not less than one gallon per 100 square feet. The curing compound container shall be equipped with a calibrated sight glass for verification of quantities used.

When the ambient temperature is above 85 degrees F, as verified by a Department-furnished calibrated thermometer, the contractor shall fog the surface of the concrete with an atomized mist of water. The surface of the pavement shall be kept moist until initial joint sawing is completed; fogging done after curing material has been applied shall not begin until the curing compound has set sufficiently to prevent displacement.

When misting is required, the entire surface of the concrete shall be kept damp by applying water with a nozzle that atomizes the flow so that a mist and not a spray is formed. The moisture from the nozzle shall not be applied under pressure directly upon the concrete and shall not be allowed to accumulate on the concrete in a quantity sufficient to cause a flow or wash the surface.

Concrete curing shall be continued for not less than seven days and any damaged curing material shall be repaired immediately.

401-3.05 Joints:

(A) General Requirements:

Joints in concrete pavement will be designated as transverse expansion joints; longitudinal or transverse construction joints; or longitudinal or transverse weakened plane joints.

The faces of all joints shall be constructed perpendicular to the surface of the concrete pavement.

Joints shall be constructed of the type, to the dimensions, and at the locations shown on the plans and as specified herein.

Concrete placed in lanes adjacent to previously placed concrete shall have transverse weakened plane joints located to align with the weakened plane joints in the previously placed concrete.

(B) Longitudinal Joints:

Longitudinal joints in the main roadway shall be weakened plane joints or construction joints. Weakened plane joints shall be constructed by sawing.

Longitudinal weakened plane joints shall be constructed between traffic lanes and also between traffic lanes and shoulders if concrete shoulders wider than five feet are specified.

Longitudinal joints in ramps and tapers shall be either weakened plane joints or construction joints. The location of longitudinal joints in ramps and tapers shall be as approved by the Engineer.

Unless otherwise shown on the plans, tie bars shall be placed in all longitudinal weakened plane joints by acceptable mechanical methods while the concrete is still plastic. When pavement is being placed adjacent to existing concrete pavement, tie bars shall be inserted

into the existing concrete by drilling 7/8 inch diameter holes into the hardened concrete. Tie bars shall be placed in accordance with the details shown on the plans and shall be anchored into the existing concrete with an approved high viscosity epoxy. The Engineer's approval of the anchoring material shall be obtained prior to starting the work.

Tie bars shall be provided as shown on the plans and spaced 30 inches center-to-center. Tie bars placed in pavement which is constructed without load transfer dowel assemblies shall be two feet long. Tie bars placed in pavement which is constructed with load transfer dowel assemblies shall be 20 inches long. Tie bars shall be placed within one inch of mid-depth of the slab. Tie bars placed in adjacent slabs of different thickness shall be placed at mid-depth of the thinner slab.

Epoxy-coated smooth dowels shall be placed in all longitudinal construction joints by acceptable mechanical methods, either while the concrete is still plastic or after the concrete has hardened. Epoxy-coated smooth dowels shall be 5/8 inch in diameter and spaced at 30 inches center-to-center. Dowels shall be two feet in length without load transfer dowel assemblies and 20 inches in length with load transfer dowel assemblies. All dowel bars shall be placed at mid-depth in the slab.

(C) Transverse Joints:

Transverse expansion joints shall be located at the junction of roadway pavement slabs and bridge approach slabs. The joints shall be formed in accordance with the details shown on the plans. Transverse expansion joints at locations other than bridge approaches shall be constructed as shown on the plans.

Transverse construction joints with tie bars shall be formed as shown on the plans and as specified herein. They shall be placed at the end of each day's production, or when placement of concrete is discontinued for more than 90 minutes. Excess concrete shall not be placed beyond a construction joint at the end of a day's production.

Transverse construction joints between transverse weakened plane joints shall have deformed No. 8 reinforcing tie bars, two feet in length, spaced at 30 inches center-to-center.

Transverse construction joints shall be formed perpendicular to the center line of the roadway.

Transverse weakened plane joints in ramps and crossroads shall be constructed perpendicular to the centerline of the ramp or crossroad.

The location of transverse weakened plane joints and transverse construction joints shall be as shown on the plans.

401-3.06 Joint Construction:

(A) Sawed Joints:

Longitudinal or transverse weakened plane joints shall be sawed to the dimensions shown on the plans. Excess water from the sawing operation will not be permitted to stand on any subgrade to be paved. The contractor shall provide and maintain acceptable methods to control the water used in the sawing so the subgrade is not damaged.

Sawed joints shall be constructed before uncontrolled pavement cracking occurs; however, joints shall not be sawed until the concrete has hardened enough to prevent excessive tearing or raveling during sawing operations. The exact time when sawing will be done shall be determined by the contractor.

The contractor shall maintain an additional concrete span saw on the project site at all times during which sawed joints are being constructed. The additional saw shall be maintained in good operating condition and shall be readily available as a substitute for the primary concrete saw.

Any procedure used to saw joints which results in premature uncontrolled cracking shall be revised immediately. The contractor shall repair damaged areas or random cracks as specified and as directed by the Engineer.

If joints are sawed in stages, the initial saw cut shall be of the minimum specified width and shall be sawed to the depth shown on the plans.

Suitable guide lines or other devices shall be used to assure that joints are constructed at the locations shown on the plans.

After sawing the joints the following procedure shall apply:

- (1) Prior to applying the sealant each joint face shall be thoroughly cleaned. The method of cleaning may be subject to regulation by state or local environmental quality enforcement agencies. When not otherwise mandated by law or regulation, the contractor shall clean the joints by sand blasting. The joints shall then be further cleaned by use of high pressure air jets so that each face is clean, dry and dust free. The air used in cleaning shall be free of oil or water.
- (2) The sealant used shall be silicone joint sealant conforming to the requirements of Subsection 1011-8 and shall be applied in accordance with the manufacturer's recommendations. All recommended manufacturer's field testing shall be done by the Engineer. Necessary repairs resulting from field testing shall be immediately repaired by the contractor; cost to be considered incidental to the sealant pay item. Any sealant spilled on the concrete pavement shall be removed.
- (3) Immediately prior to applying joint sealant, an expanded closed cell polyethylene foam backer rod, approved by the Engineer shall be inserted along the joint as shown on the plans. The backer rod shall be compatible with the joint sealant to be applied.

Joints shall be sealed within 10 working days after the concrete has been placed and prior to opening the pavement to any traffic.

(B) Construction Joints:

Longitudinal and transverse construction joints shall be formed in accordance with the details shown on the plans or as directed by the Engineer.

When concrete is not finished, textured, and protected with curing material within one hour after placement, the Engineer may order the contractor to construct a transverse construction joint by sawing at the location established by the Engineer. All concrete placed beyond the construction joint shall be removed and disposed of by the contractor, at no additional cost to the Department, prior to continuing paving operations.

An "H" expansion joint, as shown in Standard Drawing C-7.01, shall be placed where piers, abutments, barrier transitions, light pole foundations, sign structure foundations, catch basins, slotted drains or any other concrete facilities are constructed against the edge of the pavement, unless otherwise shown on the plans.

(C) Transverse Expansion Joints:

Transverse expansion joints shall be formed in accordance with the details shown on the project plans or as directed by the Engineer.

401-3.07 Opening Pavement to Traffic:

Pavement shall not be opened to traffic less than seven days after placement, and until all joints are sealed and the concrete has attained a compressive strength of at least 3,000 pounds per square inch, unless otherwise approved by the Engineer.

401-4 Pavement Evaluation and Remedial Measures:

401-4.01 Pavement Surface Texture:

The depth of surface texture grooves, will be measured in accordance with the requirements of Arizona Test Method 310.

401-4.02 Pavement Smoothness:

Pavement smoothness shall be evaluated by testing with a profilograph.

Profilograph equipment will be furnished by the Department. All profilograph measurements shall be made by a team composed of one Department employee and one contractor employee. The work shall be shared equally. At the completion of each profilograph run both operators shall sign the profilogram, certifying that they are in agreement that the equipment was found to be operating correctly and that the profilogram is a correct representation of the surface profile.

A pavement Profile Index shall be obtained as soon as possible after concrete placement.

Two profilograph readings shall be taken in each mainline traffic lane, each distress lane and each ramp lane including tapers. The profilograph readings shall be taken in the vehicle wheel paths, three feet from each lane edge of traffic lanes or 18 inches from the lane edge or pavement edge of distress lanes.

The tested profile shall begin 50 feet prior to the concrete placed during any day's production and shall end 50 feet before the end of the placed concrete. The tested profile will include bridge approaches and 50 feet of any pavement which abuts the new pavement.

If, during any day's production, less than 3,000 lane-feet of pavement is placed, that pavement shall be tested with the subsequent day's production.

The contractor shall broom the pavement or clean the pavement by other approved methods immediately prior to profilograph testing.

Surface profiles will be evaluated by the Department in accordance with the provisions of Arizona Test Method 801. The Profile Index for a traffic lane will be the average of the two Profile Indexes obtained for that lane.

All mainline traffic lanes, distress lanes, ramp lanes and tapers shall have a Profile Index of nine inches or less per mile in any 0.1-mile section.

Payment for mainline traffic lanes will be adjusted in accordance with Subsection 401-6, based on the Profile Index of the traffic lanes.

Profile Indexes greater than nine inches per mile per 0.1-mile section shall be reduced to less than nine inches per mile per 0.1-mile section by grinding or pavement removal and replacement as specified herein.

Grinding of pavement which has a Profile Index of nine inches per mile per 0.1-mile section will only be permitted to correct deviations in excess of 0.3 inches in 25 feet ("must-grinds") as specified herein and when directed by the Engineer.

The contractor shall remove high pavement areas with vertical deviations greater than 0.3 inches in 25 feet or less. High pavement areas shall be removed with grinding devices or multiple-saw devices as approved by the Engineer. Grinding machines shall be of the rotary type with a wheel base of at least 10 feet and with vertically adjustable grinding wheels. Bush hammers or other impact devices shall not be used.

After removal of high areas, the affected 0.1-mile pavement section shall be reprofiled; however, if the original Profile Index for the pavement section was within the specified range, only that portion of the pavement which originally contained high areas shall be reprofiled.

Evaluations of pavement depressions will be made based on the presumed correction of adjacent high areas. When the pavement contains depressions greater than 0.3 inches in

25 feet or less, the contractor shall grind adjacent pavement as directed by the Engineer and the pavement shall be reprofiled as specified above.

When the pavement contains depressions greater than 0.5 inches in 25 feet or less, the pavement shall be repaired as directed by the Engineer. Such repairs may include additional grinding or full-depth pavement replacement. Upon completion of repairs, the pavement shall be reprofiled as required.

If, after the repair of high and/or depressed areas, the pavement does not conform to the specified profile requirements, additional pavement grinding and profile measurements shall be performed as directed by the Engineer.

In addition to the Surface Profile Index requirements, the pavement surface will be tested with a 10-foot straightedge. The surface shall not vary in any direction by more than 1/8 inch, except at longitudinal and transverse construction joints. The surface shall not vary by more than 1/4 inch across any longitudinal or transverse construction joint. Grinding will be required to insure that these requirements are satisfied.

The pavement shall be ground in a manner that does not form a smooth or polished pavement surface.

All pavement profile repairs shall be made prior to pavement thickness evaluations.

Remedial work required to correct pavement smoothness deficiencies shall be performed by the contractor at no additional expense to the Department.

The contractor shall provide for the maintenance and protection of traffic during pavement profile repairs and subsequent pavement profile measurements as directed by the Engineer and at no additional expense to the Department.

401-4.03 Pavement Cracks:

(A) General:

Cracks penetrating the full depth of the pavement shall be repaired or the cracked pavement shall be removed and replaced, as specified herein, prior to opening the pavement to public traffic.

Within 28 days after concrete placement and prior to acceptance of the work, the Engineer will perform a pavement crack survey. The pavement shall be cleaned prior to the crack survey.

Cracks which are visible without magnification and which require repair and pavement slabs which require replacement will be marked by the Engineer and shall be repaired or replaced by the contractor as specified, and at no additional cost to the Department.

Cracks observed later than 28 days after concrete placement and prior to final acceptance of the work shall be repaired by the contractor as specified and the cost of such repairs will be shared equally by the contractor and the Department.

The contractor shall provide the Engineer with detailed information concerning the methods and materials to be used for crack repair and the contractor shall obtain the Engineer's approval of the proposed methods and materials prior to beginning the required repairs.

The contractor, at its option and at no additional cost to the Department, may core cracked pavement, as approved by the Engineer, to determine the extent of cracking.

(B) Crack Repair:

(1) General:

Random cracks shall be repaired using the methods and under the conditions specified herein.

Crack repair shall begin within seven days after completion of the pavement crack survey and shall be completed within 30 days after the start of repairs.

Payment for pavement slabs which require repairs will be adjusted as specified in Subsection 401-6.

(2) Crack Repair Requirements:

(a) Cracks in Jointed Pavement Constructed With Load-Transfer Dowel Assemblies:

Longitudinal cracks which occur more than 54 inches from a longitudinal joint or less than 12 inches from a longitudinal joint shall be repaired by the routing-and-sealing method.

Transverse cracks shall be repaired by the epoxy-injection method after any immediately adjacent uncracked joints are deepened to 1/2 inch above the dowels.

(b) Cracks in Jointed Pavement Constructed Without Load-Transfer Dowel Assemblies:

Longitudinal cracks which occur more than 54 inches from a longitudinal joint or less than 12 inches from a longitudinal joint shall be repaired by the routing-and-sealing method.

When a transverse crack crosses or terminates in a transverse contraction joint, the uncracked portion of the joint shall be filled with an approved gray colored epoxy and the crack shall be repaired by the routing-and-sealing method.

When a transverse crack approximately parallels and is within five feet of an uncracked contraction joint, the uncracked joint shall be cleaned and filled with an approved gray colored epoxy and the crack shall be repaired by the routing-and-sealing method.

When a transverse crack is more than five feet from a transverse joint, either cracked or uncracked, the joint shall be resawed and resealed as originally specified, and the crack shall be repaired by the routing-and-sealing method.

(c) Cracks Occurring Within Wheel Path:

Cracks occurring within the wheel paths, which are exclusive of the areas defined under subsections (a) and (b) above, shall be considered unrepairable and the pavement shall be removed and replaced in accordance with the requirements of Subsection 401-4.03(C).

(3) Crack Repair Methods:

(a) Routing-and-Sealing Method:

When the routing-and-sealing crack repair method is specified, the top of the crack shall be routed, with an approved routing machine, to a depth of at least 3/4 inch and to a width not less than 3/8 inch or more than 5/8 inch. The routing machine shall be capable of closely following the path of the crack and of widening the top of the crack to the required section without spalling or otherwise damaging the concrete. Loose and fractured concrete shall be removed and the routed crack shall be thoroughly cleaned and then sealed with an approved gray colored silicon sealant.

(b) Epoxy-Injection Method:

When the epoxy-injection crack repair method is specified, the crack shall be pressure injected with an approved gray colored epoxy.

Pressure injection of epoxy shall be done only between the hours of 11:00 p.m. and 7:00 a.m.

(C) Pavement Removal and Replacement:

Portland cement concrete pavement, having cracks not repairable in accordance with Subsection 401-4.03(B), shall be removed and replaced as directed by the Engineer.

Cracked pavement shall be removed and replaced to the limits established by the Engineer and will generally require removal of the full lane width of the slab over a length of at least six feet.

Pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner shall be repaired by removing and replacing the smaller portion of the slab as directed by the Engineer.

Pavement slabs containing multiple cracks through the full depth of the slab, separating the slab into three or more parts, shall be entirely removed and replaced as directed by the Engineer.

Excessively cracked pavement shall be removed and replaced over the full pavement width, as directed by the Engineer.

Pavement to be removed shall be cut full-depth prior to removal. In order to minimize over-cutting, four-inch diameter full-depth cores shall be drilled at the corners of the pavement to be removed as directed by the Engineer.

Base material which is damaged as a result of pavement removal shall be repaired or replaced by the contractor as approved by the Engineer.

Removed pavement and base material shall be disposed of by the contractor, as approved by the Engineer.

After removal of cracked pavement, tie bars and dowel bars shall be placed by drilling and anchoring, using an approved epoxy, at approximately mid-depth in the existing concrete pavement. Tie bars shall be placed in transverse construction joints and shall be 24-inch long, deformed, No. 8 bars placed 18 inches center-to-center. Tie bars shall be placed in longitudinal construction joints which are greater than 50 feet in length and shall be 24-inch long, deformed, No. 5 bars placed 30 inches center-to-center. Dowel bars shall be placed in construction joints which coincide with existing transverse weakened plane joints. The dowel bars shall be 18-inch long, smooth, 1-1/4 inch diameter bars placed at distances of 6, 24, 42, 90, 117, and 135 inches from the adjacent longitudinal joint which is nearest to the outside distress lane.

Replacement concrete shall be placed, finished and cured in accordance with the requirements specified for the original pavement.

401-4.04 Pavement Thickness:

Concrete pavement shall be constructed to the specified thickness. Tolerances allowed for base and subgrade construction and other provisions of these specifications which may affect thickness shall not be construed to modify such thickness requirements.

Pavement will be evaluated for thickness by the lot. Lot limits will be identical to those specified in Subsection 1006-7.03 for acceptance and payment for compressive strength of class P concrete. The contractor shall obtain ten cores per lot, in accordance with AASHTO T 24, under the observation of an ADOT representative, and at randomly selected locations designated by the Engineer. The ADOT representative shall take immediate custody of the cores. All cores will be measured by the Department in accordance with the provisions of AASHTO T 148, except that measurements will be to the nearest thousandth of an inch, and the average of such measurements will be to the nearest hundredth of an inch. If any core indicates a deficiency in thickness of 0.60 inches or more, that core shall not be used for determining thickness properties of the lot, and additional cores shall be drilled at intervals not exceeding ten feet in each direction from the deficient core location, measured parallel to the center line, until one core is obtained in each direction which is not deficient by 0.60 inches or more. Pavement between these two cores shall be considered as rejected. The average of the measurements of the two cores will replace the

measurements of the original deficient core in determining thickness properties of the remainder of the lot. Cores taken in areas requiring grinding will be re-cored for determination of lot thickness.

At all locations where cores have been drilled, the resulting holes shall be filled with concrete as approved by the Engineer and at no additional cost to the Department.

401-5 Method of Measurement:

Portland cement concrete pavement will be measured by the square yard, calculated from the dimensions shown on the plans and adjusted by the amount of any change ordered by the Engineer. Any opening in excess of one square yard will not be measured for payment. No allowance will be made for pavement placed in excess of the specified dimensions.

401-6 Basis of Payment:

The accepted quantities of Portland cement concrete pavement, measured as provided above, will be paid for at the contract unit price which shall include full payment for furnishing all labor, materials, tools, equipment and incidentals, and for doing all the work involved in constructing the pavement complete in place as shown on the plans and specified herein. When load transfer dowel assemblies are specified, separate payment for this work will be as specified in the Special Provisions.

Cracked pavement slabs which require repair in accordance with the provisions of Subsection 401-4.03(B) will be paid for at 80 percent of the contract unit price for the pavement repaired, as measured between the original longitudinal and transverse pavement joints abutting the repaired pavement; however, no adjustment to the contract unit price will be made for pavement slabs which contain only cracks which are observed later than 28 days after concrete placement. Unit price adjustments for cracked pavement slabs which require repair will be made independently of all unit price adjustments made for compressive strength, pavement thickness, and pavement smoothness.

Payment for thickness will be by the lot as described in Subsection 401-4.04. For each lot, pay factors will be determined for increasing or decreasing the unit price or rejection of the lot. For each lot, the following properties will be determined:

Average (AVE): The average of the measurements of the cores obtained in accordance with Subsection 401-4.04. The average will be determined to the nearest hundredth of an inch.

Standard Deviation (s): The square root of the value formed by summing the squared differences between the measurements and AVE, divided by the number of samples minus one. Standard deviation will be reported to two decimal places.

Lower Limit (LL): The required thickness less 0.2 inches.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

QL will be determined to two decimal places.

Percent of Lot Within Limits (PWL): Determined by entering Table 401-1 with QL.

Pay Factor: Determined by entering Table 401-3 with PWL.

TABLE 401-1			
Determination of PWL for Thickness			
N = 10			
QL	PWL	QL	PWL
0.24 and below	Less than 60	0.84 - 0.86	80
0.25 - 0.27	60	0.87 - 0.90	81
0.28 - 0.30	61	0.91 - 0.94	82
0.31 - 0.32	62	0.95 - 0.97	83
0.33 - 0.35	63	0.98 - 1.01	84
0.36 - 0.38	64	1.02 - 1.05	85
0.39 - 0.41	65	1.06 - 1.09	86
0.42 - 0.43	66	1.10 - 1.14	87
0.44 - 0.46	67	1.15 - 1.18	88
0.47 - 0.49	68	1.19 - 1.23	89
0.50 - 0.52	69	1.24 - 1.28	90
0.53 - 0.55	70	1.29 - 1.33	91
0.56 - 0.58	71	1.34 - 1.39	92
0.59 - 0.61	72	1.40 - 1.45	93
0.62 - 0.64	73	1.46 - 1.52	94
0.65 - 0.67	74	1.53 - 1.60	95
0.68 - 0.70	75	1.61 - 1.68	96
0.71 - 0.73	76	1.69 - 1.79	97
0.74 - 0.76	77	1.80 - 1.93	98
0.77 - 0.80	78	1.94 - 2.17	99
0.81 - 0.83	79	2.18 and above	100

Payment for compressive strength will be by the lot as described in Section 1006. For each lot, pay factors will be determined for increasing or decreasing the unit price of the lot or rejection of the lot. For each lot, the following properties will be determined:

Average (AVE): The average of the compressive strengths of the samples. The average will be determined to the nearest whole number.

Standard Deviation (s): The square root of the value formed by summing the squared difference between the compressive strength results of each sample and AVE, divided by the number of samples minus one. The standard deviation will be determined to the nearest whole number.

Lower Limit (LL): The specified minimum strength.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

QL will be determined to two decimal places.

Percent of Lot Within Limits (PWL): Determined by entering Table 401-2 with QL.

Pay Factor (PF): Determined by entering Table 401-3 with PWL.

TABLE 401-2			
Determination of PWL for Compressive Strength			
N = 5			
QL	PWL	QL	PWL
0.26 and below	Less than 60	0.87 - 0.89	80
0.27 - 0.29	60	0.90 - 0.92	81
0.30 - 0.32	61	0.93 - 0.96	82
0.33 - 0.35	62	0.97 - 0.99	83
0.36 - 0.38	63	1.00 - 1.03	84
0.39 - 0.41	64	1.04 - 1.06	85
0.42 - 0.43	65	1.07 - 1.09	86
0.44 - 0.47	66	1.10 - 1.13	87
0.48 - 0.49	67	1.14 - 1.17	88
0.50 - 0.52	68	1.18 - 1.21	89
0.53 - 0.55	69	1.22 - 1.24	90
0.56 - 0.58	70	1.25 - 1.29	91
0.59 - 0.61	71	1.30 - 1.32	92
0.62 - 0.64	72	1.33 - 1.37	93
0.65 - 0.67	73	1.38 - 1.42	94
0.68 - 0.70	74	1.43 - 1.46	95
0.71 - 0.73	75	1.47 - 1.51	96
0.74 - 0.76	76	1.52 - 1.56	97
0.77 - 0.80	77	1.57 - 1.63	98
0.81 - 0.83	78	1.64 - 1.72	99
0.84 - 0.86	79	1.73 and above	100

TABLE 401-3	
Pay Factors for Thickness and Compressive Strength	
PWL	Pay Factor (Dollars/Square Yard)
100	+1.00

TABLE 401-3	
Pay Factors for Thickness and Compressive Strength	
PWL	Pay Factor (Dollars/Square Yard)
95-99	+0.75
90-94	+0.50
85-89	0.00
80-84	-0.25
75-79	-0.75
70-74	-1.75
65-69	-3.25
60-64	-5.00
Below 60	Reject

Pay Factors for thickness and compressive strength will be applied separately and totaled to determine a total Pay Factor. Any lot with a total Pay Factor less than minus \$5.00 will be rejected.

The unit price paid for pavement on mainline traffic lanes and freeway-to-freeway ramps which have a Profile Index less than or equal to 9.0 inches per mile per 0.1-mile section after correction of all deviations in excess of 0.3 inches in 25 feet ("must-grinds") will be adjusted in accordance with Table 401-4.

TABLE 401-4	
Profile Index (P.I.) [inches per mile per 0.1 mile section]	Unit Price Adjustment
7.0 or Less	Plus $(\$0.20) \times [7.0 - (P.I.*)]$ per square yard (\$1.00 Maximum) (See Notes)
7.1 to 8.0	Minus \$0.50 per square yard
8.1 to 9.0	Minus \$1.00 per square yard
Notes: 1. P.I.* = Profile Index (P.I.) rounded to the nearest whole number. 2. The "plus" unit price adjustment will not be made for pavement placed within each 0.1-mile section which has grinding in excess of 1.5 percent of the area included in any traffic lane involved.	

Unit price adjustments for pavement smoothness will not be made for pavement in distress lanes, shoulders, service interchange ramps, tapers, cross roads, or frontage roads.

Unit price adjustments for pavement smoothness will be made independently of all unit price adjustments made for pavement thickness, compressive strength, and cracked pavement slabs which require repair.

Pavement rejected in accordance with this Section or Section 1006 shall be removed and replaced with pavement meeting the requirements of both sections. However, within ten

days of notification of rejected pavement, the contractor may submit a written proposal to accept the pavement at a reduced unit price. When the contractor has elected to rely on the results of core testing for compressive strength, the ten days will commence upon notification of the results of core testing. Such proposal shall contain an engineering analysis of the anticipated performance of the pavement if allowed to remain in place. The reduction in unit price shall reflect the commensurate reduction in life expectancy, but in no case shall it be less than the total of the negative pay factors involved. Within five working days after receiving the contractor's proposal, the Engineer will determine whether or not to accept it and will so notify the contractor. If the proposal is not accepted, the pavement shall be removed and replaced as hereinbefore specified. If the proposal is accepted, the Engineer will specify the conditions of acceptance.

SECTION 402 PORTLAND CEMENT CONCRETE PAVEMENT REPAIRS:

402-1 Description:

The work under this section shall consist of furnishing all labor, materials and equipment necessary to repair Portland cement concrete pavement in accordance with the requirements of these specifications and as shown on the project plans or established by the Engineer.

The kind of Portland cement concrete pavement repair may consist of one or a combination of the following:

- Spall Repairs
- Slab Repairs
- Pavement Grinding
- Pavement Grooving
- Joint and Crack Repair
- Edge Sealing

402-2 Spall Repairs:

402-2.01 Description:

The work shall consist of furnishing all materials and removing loose material and temporary bituminous patch material from potholes, damaged joints, and spalled areas, thoroughly cleaning the repair area and placing new patch material in accordance with the details shown on the project plans and as specified herein, and in reasonably close conformity with the existing pavement cross-section.

402-2.02 Material Requirements:

(A) General:

Patch materials shall attain compressive strength of 2,000 pounds per square inch within six hours. The patch material shall attain the required compressive strength prior to opening to traffic.

(B) Accelerated Strength Portland Cement Concrete Patch Material:

The patch material shall be an Accelerated Strength Portland Cement Concrete mixture consisting of Type III Portland Cement and calcium chloride or other accelerators meeting AASHTO M 144 and shall attain a compressive strength of at least 2,000 pounds per square inch in six hours. Materials for the concrete mix shall conform to the requirements of Section 1006 for Class S concrete. The coarse aggregate shall be as designated for size No. 67 in accordance with AASHTO M 43.

(C) Rapid Setting Patch Material:

Rapid setting patch material shall be a product approved by the Engineer. A list of approved patch materials is maintained on the Department's approved product list.

(D) Epoxy Resin Grout Patch Material:

Epoxy resin patch material shall be a low modulus moisture insensitive epoxy mortar grout prepared in accordance with the manufacturer's recommendations. Fine aggregate incorporated into the grout shall meet the fine aggregate gradation requirements specified in Subsection 1006-2.03(B). The epoxy binder:aggregate ratio shall be between 1:7 and 1:10. The epoxy binder materials shall meet the requirements specified in ASTM C 881.

(E) Flexible Epoxy Patching Material:

(1) Description:

The patching material shall be a mixture of a solventless, medium curing time, stress relieved flexible coating epoxy and 100 percent vulcanized granulated rubber.

(2) Materials:

The epoxy shall be a two component, low viscosity mixture and have a gray color when mixed. The curing period shall be seven days at standard laboratory conditions. The cured epoxy shall meet the following physical requirements:

Test Method Requirements	Test	Material
ASTM D 638	Tensile Strength: psi	900 (minimum)
ASTM D 638	Tensile Elongation: %	85 (minimum)
Gardner	Impact Resistance: pounds Direct Reverse	greater than 160 greater than 80
AASHTO T 237	Tensile Bond Strength: psi	310 (minimum)
ASTM D 648	Heat Deflection Temperature: °F	25
ASTM D 2240	Hardness: Shore D	62 (minimum)
AASHTO T 237	Slant Shear Strength: psi	2,000 (minimum)

The ground rubber shall be free of fabric, wire or other contaminating materials.

(3) Packaging and Marking:

The ground rubber shall be introduced into each of the two components by the manufacturer at the place of production, not at the job site. Each container of both components shall be labeled and legibly marked with the manufacturer's name, the trade name of the product, component identification and the expiration date of the manufacturer's shelf life warranty. Material that has exceeded the shelf life warranty expiration date shall not be used.

(4) Certification Requirements:

A Certification of Compliance conforming to the requirements of Subsection 106.05 shall be submitted.

402-2.03 Construction Requirements:

(A) General:

Spalled areas to be repaired will be designated by the Engineer and shall be repaired prior to any required pavement grinding. The extent of the repair area will be marked by the Engineer and will be no less than three inches outside the area of delamination. The Engineer will be the final authority if questions arise in regard to the need for patching or the extent of a required patch.

Spalled areas less than six inches in length and 1-1/2 inches in width, which are adjacent to joints, shall not be repaired under this specification.

Patching material shall not be placed under conditions which will adversely affect the quality of work. The Engineer shall be the sole judge in determining the suitability of working conditions.

Concrete within the patch area shall be broken out, to the minimum depth specified for the patch material being used, with light to medium pneumatic tools until sound clean concrete is exposed. If the depth of the spalled area exceeds half the thickness of the concrete pavement slab, the affected pavement shall be removed and replaced, as designated by the Engineer and in accordance with the requirements of Subsection 402-3.

Asphaltic concrete shoulders adjacent to a patch shall be cut longitudinally to the depth of the patch and to a width of not more than 12 inches. The cut shall extend one foot beyond both transverse limits of the patch to facilitate placement of form work. Shoulders shall be patched with material similar to the existing shoulder material.

Prior to patching, the exposed faces of the concrete shall be sandblasted free of loose particles, oil, dust, traces of asphaltic concrete and other contaminants. Prior to placement of the bonding agent, all sandblasting residue shall be removed with compressed air and

high suction vacuums. Sand for sandblasting shall be sharp and clean and capable of passing a No. 10 sieve and shall leave the exposed concrete face clean and dry.

The surface of the spalled area or breakup shall be clean and dry so that patching material will form a proper bond. The area to be cleaned and patched shall be limited to the area designated by the Engineer. Patching material shall be confined to the limits of the repair and shall not lap onto the surrounding pavement.

Patch material shall be placed or consolidated to eliminate voids at the interface of the patch and existing concrete. If a partial depth repair area abuts a working joint or crack which penetrates the full depth of the slab, a temporary insert or other bond-breaking medium such as styrofoam strips shall be used to maintain the working joint or crack for the full depth of the patch and at the same width as the existing joint or crack while placing patch material. Repair material shall not bear on an adjacent slab.

The patch shall be finished to the cross-section of the existing pavement and textured with a stiff bristled brush. Texturing shall conform to that of the existing pavement. The patch surface shall be struck off flush with the existing pavement surface.

(B) Accelerated Strength Portland Cement Concrete Pavement Patch:

Patch boundaries shall be saw cut and broken out to a depth of at least 1-1/2 inches.

Following the removal and cleaning of the area to be patched, and prior to placing patch material, an approved bonding agent shall be applied to the patch area. The bonding agent shall be applied in a thin coating and scrubbed into the surface with a stiff bristled brush. Placement of patch material shall be delayed until the bonding agent becomes tacky.

(C) Rapid Setting Patch:

Rapid set patch materials shall be installed in accordance with manufacturer's instructions. In order to assure proper mixing and placement, a qualified manufacturer's representative for the approved product shall be present at the start of spall repair operations, and shall remain until the Engineer is satisfied that the contractor is conforming to the recommended procedures.

Patch boundaries shall be saw cut and broken out to a depth of at least 1-1/2 inches, or as recommended by the manufacturer, whichever is greater.

If recommended by the manufacturer, the area to be patched shall be primed with a bonding agent compatible with the patch material being used.

(D) Epoxy-Resin Grout Patch:

Patch boundaries shall be saw cut and broken out to a minimum depth of 1-1/2 inches.

Prior to placement of epoxy-resin grout, the contractor shall furnish a grout mix design for review and approval.

The epoxy-components shall be mixed in strict compliance with the manufacturer's recommendations before aggregate is added to the mixture.

(E) Flexible Epoxy Patch:

Use of flexible epoxy materials shall be in accordance with the manufacturer's recommendations unless otherwise specified by the Engineer.

The contractor shall remove the spall area to be replaced to a minimum depth of two inches or to a solid surface by saw cutting and chipping with a pneumatic hammer, without damaging the underlying intact concrete. All loose particles shall be removed before applying the flexible epoxy inlay.

The contractor shall mix only the amount of material that can be used before the expiration of the pot life for the material. The two parts shall be thoroughly mixed in their own containers before combining the parts together as recommended by the manufacturer. The contractor shall blend the mix thoroughly for the length of time recommended by the manufacturer, making sure the material contains no lumps or streaks, and carefully scraping the sides and bottom of the container.

The material shall be placed in the area to be patched, the surface leveled off even with the surrounding pavement, and any excess material removed.

402-2.04 Method of Measurement:

Spall repairs will be measured by the square foot for all patches constructed. Each patch will be measured to the nearest one-tenth square foot. The total cumulative measurement of all patches will be rounded to the nearest square foot.

402-2.05 Basis of Payment:

The accepted quantities of spall repairs, measured as provided above, will be paid for at the contract unit price per square foot, which price shall be full compensation for the work, complete in place including removal and disposal of the old pavement; and repair or replacement of shoulder material which is removed or damaged during spall repair work.

402-3 Full Depth Slab Repairs:

402-3.01 Description:

The work shall consist of furnishing all materials and removing existing concrete pavement and constructing full depth patches of Portland cement concrete pavement at the locations shown on the project plans, as specified herein, and in reasonably close conformity with the existing pavement cross-sections.

402-3.02 Material Requirements:

Patching material shall be an Accelerated Strength Portland Cement Concrete Mixture which includes Type III Portland Cement and calcium chloride or other accelerator conforming to the requirements of AASHTO M 144. The patch material shall attain a compressive strength of at least 2,000 pounds per square inch in six hours. The contractor shall not place concrete patch material until the mix design has been tested and approved by the Engineer.

Materials for Portland Cement Concrete shall conform to the requirements of Section 1006. Concrete shall be Class S, with size 57 coarse aggregate as designated in AASHTO M 43.

Materials furnished for joint seal shall conform to the requirements of Subsection 1011-3.

Materials furnished for tie bars shall conform to the requirements of Section 1003.

Materials furnished for dowel bars shall conform to the requirements of AASHTO M 254 with Type B coating except that the core material shall conform to the requirements of ASTM A 615, Grade 40.

Liquid membrane-forming curing compound shall conform to the requirements of Subsection 1006-2.05.

402-3.03 Construction Requirements:

Areas to be repaired will be designated by the Engineer and shall be repaired before any specified pavement grinding. The Engineer shall be the final authority if questions arise with regard to the need for patching or the extent of the patch.

Patching material shall not be placed under any conditions which will adversely affect the quality of the work. If these conditions arise, the Engineer will determine whether or not the operation should cease. The Engineer shall be the sole judge in determining the suitability of working conditions.

Pavement slabs containing multiple cracks through the full depth of the slab, separating the slab into three or more parts and other slabs designated by the Engineer, shall be entirely removed and replaced. Pavement slabs containing a single diagonal crack intersecting the transverse and longitudinal joints within 1/3 of the width and length of the slab from the corner shall be repaired by removing and replacing the smaller portion of the slab.

Areas to be patched shall have the configuration and minimum dimensions shown in the plans. The area shall be saw cut to the full depth of the slab. An additional full depth saw cut shall be made interior to one of the initial transverse saw cuts and shall be made such that a wedge tapering from four inches to six inches from the initial cut is created.

The area inside the wedge shall be removed with light to medium weight jackhammers or other approved equipment prior to removing the larger remaining pavement section. The remaining pavement shall be lifted out in a manner approved by the Engineer. Any disturbed granular subbase shall be removed and replaced with concrete patch material and any spalls which are caused by the removal operations and which are greater than one

inch wide or one inch deep, shall be repaired by resawing full depth and full width of the traveled lane, or repaired as directed by the Engineer at no additional cost to the Department.

When the patch boundary is at an existing contraction joint, the new joint shall be formed with plain round dowel bars, 1-1/4 inches in diameter and 18 inches in length. Dowel bars shall be placed as shown in the plans, and shall be placed at mid-depth of the existing slab. Holes drilled for the dowel bars shall not be less than 1-3/8 inches in diameter and shall extend nine inches into the existing slab. The bars shall be anchored into the existing concrete with an approved high viscosity epoxy. Prior to concrete placement for the replacement slab, the nine-inch long free end of the dowel bar shall be uniformly coated with a thin film of heavy waterproof grease.

When the patch boundary is at an existing longitudinal joint, the patch shall be tied to existing concrete with two-foot long No. 5 deformed steel tie bars placed in the joint at 30-inch intervals as shown on the plans. Holes drilled in the existing slab shall be one foot deep and of a diameter sufficient to accommodate the tie bars. The tie bars shall be anchored into the existing slab using an approved high viscosity epoxy.

When the patch boundary is located near mid slab, the patch shall be tied to existing concrete with two-foot long No. 8 deformed steel tie bars placed in the transverse joint at 18-inch intervals and No. 5 deformed steel tie bars placed in the longitudinal joint at 30-inch intervals as shown in the plans. Holes drilled in the existing slab shall be one foot deep and of a diameter sufficient to accommodate the tie bars. The tie bars shall be anchored into the existing slab using an approved high viscosity epoxy.

Patch material shall be placed and consolidated to eliminate voids at the interface of the patch and existing concrete. A new sealant reservoir shall be sawed or formed at the interface of the patch and existing concrete, as shown on the plans.

The patch shall be finished to the cross-section of the existing pavement and textured with a stiff bristled brush to match the existing pavement. The patch surface shall be within 1/8 inch of the existing pavement surface. No texturing will be required if pavement grinding or grooving is to be done after patching.

402-3.04 Method of Measurement:

Slab Repairs will be measured by the square yard of pavement repaired. Each patch will be measured to the nearest one-tenth square foot. The total cumulative measurement of all pavement repaired will be rounded to the nearest square yard.

402-3.05 Basis of Payment:

The accepted quantities of slab repairs, measured as provided above, will be paid for at the contract unit price per square yard, which price shall be full compensation for the work complete in place including the removal and disposal of existing materials, the excavation and subsequent backfilling or repairs to subbase materials incidental to the removals and

the repair or replacement of shoulder materials which are damaged or removed during the work.

402-4 Pavement Grinding:

402-4.01 Description:

The work shall consist of furnishing all materials and grinding the surface of existing concrete pavement at the locations shown on the project plans and in accordance with the requirements of these specifications.

402-4.02 Blank

402-4.03 Construction Requirements:

(A) General:

Prior to grinding, spalled areas shall be repaired as specified. Grinding shall be done prior to any specified sawing and sealing of existing transverse and longitudinal joints.

Pavement surfaces shall be ground longitudinally.

The contractor shall grind a test section of pavement, where designated by the Engineer, to determine that the equipment proposed for use on the project will provide the specified surface texture.

The entire area of pavement designated to be ground shall be ground in a manner that results in a uniform surface appearance. Grinding shall continue for the full lane width until the pavement surface on both sides of all transverse joints and all cracks is in the same plane. Longitudinal ridges in adjacent passes of the grinding equipment shall not exceed 1/8 inch in depth.

In any one lane, a maximum distance of 1,000 linear feet of unfinished work area between the lead grinder and the last grinder in that lane will be allowed at the end of any work shift.

Ground surfaces shall not be smooth or polished and shall have a wet Arizona Mu-Meter number of not less than 60 at 40 miles per hour.

The surface shall have a finished texture that has grooves between 0.090 and 0.130 inches wide, spaced 0.060 to 0.110 inches apart and not less than 0.030 inches or more than 0.115 inches in depth.

The ground area of any selected two-foot by 100-foot longitudinal area of pavement specified to be ground shall not be less than 98 percent of the selected area. This selected area will be within the center eleven feet of a traffic lane.

Residue and excess water resulting from grinding shall be removed from the roadway by vacuuming or any other method approved by the Engineer. The residue shall be removed

prior to opening the lane to traffic. Residue and water from grinding operations shall not be permitted to flow across lanes occupied by traffic, onto roadway shoulders or areas containing vegetation, or to flow into gutters or other drainage facilities. Dried residue shall be broomed with a pickup or power broom prior to allowing traffic over the opened work area.

After grinding has been completed, the pavement surface will be tested in accordance with the requirements of Arizona Test Method 801. Two Profilograph readings shall be taken in the vehicle wheel paths three feet from the edge of the traffic lane.

To be acceptable, a Profile Index shall not exceed 10 inches per mile in any 0.1-mile section. In addition, all areas representing high points having deviations in excess of 0.3 inches in 25 feet, shall be reground until such deviations, as indicated by reruns of the Profilograph, do not exceed 0.3 inches in 25 feet.

Additional grinding shall be performed, if necessary, to reduce the overall Profile Index, as measured by the Profilograph, to 10 inches per mile in any 0.1-mile section or remaining portion thereof, along any line parallel to the edge of the pavement. In any areas requiring regrounding, the regrounding shall be done over the full lane width.

The contractor shall broom the surface of the concrete so that Profilometer readings can be taken. Profilograph measurements shall be the responsibility of the contractor on all but the final acceptance measurement. The contractor shall bear all costs of profilograph measurements. Traffic control for the final acceptance measurements shall be provided by the contractor.

(B) Equipment and Procedures:

Grinding shall be done with diamond blades, mounted on a self-propelled machine that has been designed for grinding and texturing of pavements. The equipment shall be designed such that it will not cause strain or damage to the underlying surface of the pavement. Grinding equipment that causes excessive ravels, aggregate fractures, spalls, or disturbances of the transverse and/or longitudinal joints shall not be used.

All grinding machines used in the cross-section of a lane shall have the same wheel or grinding head configuration. Overlapping of grinding passes will not be allowed.

The noise level created by any one machine shall not exceed 86 dbA at a distance of 50 feet normal to the direction of traffic.

No equipment will be allowed within three feet of a traffic lane open to the public. Maintenance and Protection of Traffic shall conform to the requirements of Section 701.

402-4.04 Method of Measurement:

Pavement grinding will be measured by the square yard of pavement ground and accepted. The quantity will be determined by multiplying the width by the length of the ground area.

402-4.05 Basis of Payment:

The accepted quantities of pavement grinding, measured as provided above, will be paid for at the contract unit price, which price shall be full compensation for the work complete as specified.

402-5 Pavement Grooving:

402-5.01 Description:

The work consists of furnishing all materials and grooving the surface of existing Portland Cement Concrete Pavement at the locations shown on the project plans and in accordance with the requirements of these specifications.

402-5.02 Blank

402-5.03 Construction Requirements:

(A) General:

The pavement surface shall be grooved longitudinally.

The methods used and tolerances employed shall provide a surface which will provide good wet or dry driving characteristics.

Longitudinally grooved areas shall begin and end at lines normal to the pavement center line and shall be centered within the lane width.

No equipment shall be allowed within three feet of a traffic lane open to the public. Maintenance and Protection of Traffic shall be in accordance with Section 701.

Removal of all slurry or residue resulting from the grooving operation shall be continuous. Residue from grooving operations shall not be permitted to flow across shoulders or lanes occupied by public traffic or to flow into gutters or other drainage facilities. Dried residue, resulting from grooving operations, shall be removed from pavement surfaces with a pick up or power broom before such residue is blown by the action of traffic or wind.

The noise level created by any one machine shall not exceed 86 dbA at a distance of 50 feet normal to the direction of traffic.

(B) Equipment and Procedures:

Grooving shall be done with diamond blades, mounted on a multi-blade arbor on a self-propelled machine which has been built for grooving of pavements. The groover shall have a depth control device which will detect variations in the pavement surface and adjust the cutting head height to maintain the specified groove depth. The grooving machine shall have alignment control devices. Flailing type grooving will not be permitted.

At the beginning of each work shift, all grooving machines shall be equipped with a full complement of grooving blades that are capable of cutting grooves of the specified width, depth and spacing.

If during the course of work, a single grooving blade on any individual grooving machine becomes incapable of cutting a groove, work will be permitted to continue for the remainder of the work shift and the contractor will not be required to otherwise cut the groove omitted because of the failed blade. Should two or more grooving blades on any individual grooving machine become incapable of cutting grooves, the contractor shall cease operations.

The grooved area of any selected two-foot by 100-foot longitudinal area of pavement specified to be grooved shall not be less than ninety percent of that area. Ungrooved pavement within the selected area shall be limited to that which occurs as a result of pavement irregularities.

(C) Tolerance:

Longitudinal grooving shall begin six inches from the outside edge of pavement or reflective marker and run in a continuous pattern across the lane surface to within six inches of the longitudinal joint. The groove pattern shall be 0.125 inches in width by 3/16 inch in depth with a center-to-center spacing of 3/4 inch. The groove spacing tolerance shall be plus or minus 1/8 inch. The width of the groove shall have a tolerance of plus or minus 0.015 inches. The depth of the groove shall have a tolerance of plus or minus 1/16 inch.

On curves and/or superelevations, the width of the groove may exceed the above dimensions as approved by the Engineer.

If the pavement profile is very uneven, the Engineer may permit a variation in maximum groove depth in areas adjacent to rutted pavement and/or faulted joints.

Grooving shall be terminated a minimum of one foot from any device in place in the pavement, such as manholes, inlet casting, valve boxes, etc.

402-5.04 Method of Measurement:

Pavement grooving will be measured and accepted by the square yard of grooved pavement. The quantity of grooved pavement will be determined by multiplying the width times the length of the grooved area. No deduction will be made for grooving omitted at joints, manholes, inlets or other similar installations in the pavement surface.

402-5.05 Basis of Payment:

The accepted quantities of pavement grooving, measured as provided above, will be paid for at the contract unit price per square yard, which price shall be full compensation for the work, complete as specified herein.

402-6 Joint and Crack Repair:

402-6.01 Description:

The work shall consist of furnishing all materials and renovating longitudinal and transverse contraction control joints and routing and sealing random cracks in existing Portland Cement Concrete Pavement, as specified herein, detailed on the project plans and as directed by the Engineer.

402-6.02 Material Requirements:

Joint sealant shall conform to the requirements of Section 1011.

Grout for filling wide joints shall be a low modulus moisture insensitive epoxy-resin grout of a viscosity suitable for flowing into the irregular cracked portion of the joint. The ratio of epoxy-resin:sand shall be between 1:7 and 1:10 or as specified by the epoxy manufacturer. Epoxy binder material shall conform to the requirements of ASTM C 881.

Sand used in epoxy grout shall conform to the requirements of Subsection 1006-2.03(B) except that the gradation shall be as follows:

Sieve Size	Percent Passing
No. 8	100
No. 16	95 - 100
No. 50	10 - 40
No. 200	0 - 4.0

A rapid set Portland cement concrete pavement patching material may be substituted for epoxy grout as approved by the Engineer.

402-6.03 Construction Requirements:**(A) General:**

Joint and crack repairs shall be accomplished by first removing old sealant and joint inserts, then refacing and cleaning the joints and cracks followed by installation of a backer rod (if required) and installation of new sealant.

(B) Joint and Crack Preparation:

Cracks shall be sawed or routed to the dimensions shown on the plans.

Inserts shall be removed from insert formed joints by sawing to provide a clean vertical face. The width and depth of the saw cuts shall be sufficient to insure complete removal of the insert and to provide a finished joint of the dimensions specified for the sealant material to be used. If the insert is not vertical, additional parallel saw cuts shall be provided as required to insure full removal of the inserts.

Joints that are not insert formed shall be sawed to the widths and depths specified herein. Joints previously sawed and sealed will be inspected to assure the proper dimensions and shall be resawed to the proper widths and depths, when required.

Joints shall be sawed as follows:

Initial Joint Width "W": Inches	Sawed Width: Inches	Sawed Depth "D": Inches, (1)
$W \leq 1/2$	1/2	$D = 1-3/4$
$1/2 < W \leq 3/4$	3/4	$D = 2-1/8$
$3/4 < W \leq 1-1/2$	No Sawing Required	$D = 2W + 3/4$
(1) "D" is distance from pavement surface to bottom of backer rod.		

Immediately after saw cutting a joint or routing a crack, old sealant shall be removed and the internal surfaces of the joint or crack shall be thoroughly cleaned by sandblasting. Sand for sandblasting shall be sharp and clean and shall be capable of passing a No. 10 sieve. The amount of compressed air and the nozzle pressure shall be such that the joints and cracks will be thoroughly cleaned and the edges will have etched surfaces.

(C) Dowel Placement:

Dowel bars shall be placed in transverse joints when the initial joint width is greater than 1-1/2 inches. Slots for dowel bar placement shall be made with two saw cuts perpendicular to the joint and $1-1/2 \pm 1/8$ inches apart. Saw cuts shall be one half the depth of the slab plus 1/2 inch. Concrete shall be removed between the saw cuts and smooth, epoxy coated dowels which are 1-1/4 inches in diameter and 18 inches long shall be inserted into the formed slot. Dowels shall be supported above the bottom of the slot so that epoxy grout can flow around the circumference of the dowel. Dowels shall be placed so that the dowel is embedded equal distance into the two slabs. Dowel bars shall conform to the requirements of AASHTO M 254 with Type B coating, except that the core material shall conform to the requirements of ASTM A 615, Grade 40. Dowel bars shall be placed as shown on the plans, and shall be placed at approximately mid-depth of the existing slab. The bar shall be thoroughly and uniformly coated with a waterproof grease prior to placement into the slot then covered with an approved epoxy grout. A 1/2-inch thickness of preformed joint filler shall be placed next to one edge of the joint such that a one $\pm 1/8$ -inch deep sealant reservoir can be formed at the top, as shown on the plans. The wide joint shall be filled with epoxy grout.

On longitudinal joints where the joint opening exceeds 1-1/2 inches, the saw cuts for placement of tie bars perpendicular to the joint, shall be 7/8 inch apart so that a No. 5 deformed tie bar 24 inches long can be inserted into the slot. This 24-inch tie bar shall be placed at mid slab depth and equal distance into each slab, then covered with an approved epoxy grout. The bars shall be at 36-inch spacing. The wide joint shall also be filled with epoxy grout.

(D) Cleaning Prior to Sealing:

Prior to sealing, all foreign or loosened particles shall be removed from the joints to the full depth of the original sawed joints. The removal of all foreign or loosened particles shall be accomplished with compressed air or by other methods approved by the Engineer. Air compressors shall be capable of furnishing a sufficient amount of compressed air to clean the joints properly.

(E) Separating or Blocking Medium (Backer Rod):

Immediately following the cleaning of joints and prior to the application of sealant, a backer rod composed of an inert, compressible material shall be inserted along the lower portion of the joint groove at a uniform depth as shown on the project plans.

The backer rod shall be compatible with the sealant in accordance with the manufacturer's recommendations. The product shall be clean, free of scale, foreign matter, oil or moisture and shall be non-absorbing. The Engineer shall be assured that the material proposed for use has been used successfully in similar installations.

Backer rod sizes shall be as follows:

Joint Width: Inches	Backer Rod Diameter: Inches
1/2	5/8
3/4	1
1	1-1/4
1-1/4	1-1/2
1-1/2	2

(F) Installation of Sealant:

Sealant compound shall not be placed unless the joint is dry, clean and free of dust. The face of the joint shall be surface dry and the ambient and pavement temperatures shall both be at least 50 degrees F at the time of application of the sealant. Installation of the sealant shall be such that the in-place sealant shall be well bonded to the concrete and free of voids or entrapped air. The joints shall be sealed in a neat and workmanlike manner, so that upon completion of the work, the surface of the sealant material will be $1/4 \pm 1/8$ inch below the adjacent pavement surface. The contractor shall refill all low joints before final acceptance. Any excess material on the surface of the pavement shall be removed and the pavement surface shall be left in a clean condition. Vehicular or heavy equipment traffic shall not be permitted on the pavement in the area of the joints during the curing period.

402-6.05 Method of Measurement:

Joint and crack repairs will be measured by the linear foot.

402-6.06 Basis of Payment:

The accepted quantities of joint and crack repairs, measured as provided above, will be paid for at the contract unit price per linear foot, which price shall be full compensation for the work, complete in place.

402-7 Edge Sealing:

402-7.01 Description:

The work shall consist of furnishing all materials and sawing or routing, and sealing the joints between the Portland Cement Concrete Pavement and the asphaltic concrete distress lane. This work shall be done after the completion of any specified pavement grinding and after any specified rehabilitation of the distress lane or outside shoulder. The work shall be accomplished in accordance with the details shown on the project plans and as specified herein.

402-7.02 Materials:

(A) General:

The sealant to be used shall be any one of the following:

A mixture of asphalt and 100 percent vulcanized, granulated rubber.

Premixed block material consisting of asphalt and 100 percent vulcanized rubber.

(B) Ground Rubber:

All material shall meet the requirements of these specifications and the contractor shall submit a Certificate of Compliance conforming to the requirements of Subsection 106.05.

Rubber shall be free of fabric, wire or other contaminating materials. No more than four percent by weight calcium carbonate may be included to prevent the particles from sticking together.

Rubber shall meet the following requirements when tested in accordance with Arizona Test Method 714.

Sieve Size	Asphalt Rubber (Vulcanized): % passing	Premixed Asphalt Rubber 100% (Vulcanized): % passing
No. 8	100	100
No. 10	95 - 100	95 - 100
No. 30	0 - 10	

The rubber shall have a specific gravity of 1.15 ± 0.20 .

(C) Asphalt Cement:

(1) Asphalt-Rubber (Vulcanized):

Type A:

Asphalt cement shall be an asphalt binder performance grade PG 58-22, conforming to the requirements of Section 1005.

Type B:

Asphalt cement shall be an asphalt binder performance grade PG 64-16, conforming to the requirements of Section 1005.

402-7.03 Construction Requirements:

(A) Material Mixing Requirements:

The methods used to combine the materials and the design of the equipment shall be such that the Engineer can readily determine the percentages by weight of the materials being incorporated into the mixture.

(1) Asphalt-Rubber (Vulcanized):

The mixture shall consist of 75 ± 2 percent asphalt and 25 ± 2 percent rubber by weight.

The materials shall be combined as rapidly as possible for such a time and at such a temperature that the consistency of the mixture approaches that of a semi-fluid material. Since the time required to achieve this state is a function of the temperature of the asphalt, the time may vary and shall conform to that recommended by the manufacturer.

(B) Equipment Requirements:

The equipment used in the application of the asphalt-rubber material shall have a mixing system in the heating unit in order to maintain a consistent, uniform, homogeneous mixture throughout the crack sealing operation. The equipment shall be designed to provide a continuous supply so that operations may proceed without delays.

(C) Weather:

The asphalt-rubber mixture shall not be placed during wet weather or under other conditions which will adversely affect the operations. The sealant shall not be placed in cracks which are wet.

If adverse weather conditions are such as to affect the operations, the Engineer will determine whether or not the operations should cease.

(D) Application of Asphalt-Rubber Sealant:

The joint shall be sawed in the asphaltic concrete directly adjacent to the edge of the Portland cement concrete pavement and shall be at least 1/2 inch wide and one inch deep.

Immediately prior to placement of the sealant, the joints shall be cleaned as approved by the Engineer.

402-7.04 Method of Measurement:

Edge sealing will be measured by the linear foot of longitudinal edge joint sealed.

402-7.05 Basis of Payment:

The accepted quantities of edge sealing, measured as provided above, will be paid for at the contract unit price per linear foot of edge seal, complete in place.

SECTION 403 BLANK

SECTION 404 BITUMINOUS TREATMENTS:

404-1 Description:

The work under this section shall consist of furnishing all materials and constructing or applying a single or multiple course bituminous treatment in accordance with the requirements of these specifications and in reasonably close conformity to the lines shown on the project plans or established by the Engineer.

The kind of bituminous treatment may consist of one or a combination of the following:

- Prime Coat
- Tack Coat
- Fog Coat
- Chip Seal Coat

404-2 Materials:

404-2.01 Bituminous Materials:

The bituminous material shall be of the type and grade specified in the Special Provisions and shall conform to the requirements of the following subsections:

Asphalt Cement	1005-3.01
Liquid Asphalt	1005-3.02
Emulsified Asphalt	1005-3.03
Emulsified Asphalt (Special Type)	1005-3.04
Recycling Agents	1005-3.05
Emulsified Recycling Agents	1005-3.06

Application temperatures of bituminous materials shall conform to the requirements of Table 1005-6.

404-2.02 Aggregate Materials:

(A) General:

There is no Department-furnished source of aggregate material. The contractor shall provide a source in accordance with the requirements of Section 1001.

Aggregate material will be sampled for acceptance in the final stockpile before incorporation into the work. The aggregate material will be deemed to be acceptable when the test values for each specified aggregate characteristic are within the specified limits.

(B) Blotter Material:

Blotter material shall be a natural sand, crushed sand, volcanic cinders, or other approved material and shall be free of deleterious amounts of foreign substances.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	80 - 100
No. 16	45 - 80
No. 200	0 - 5.0

(C) Cover Material:

Aggregate for cover material shall be of clean sand, gravel or crushed rock and shall be free from lumps or balls of clay and shall not contain calcareous or clay coatings, caliche, synthetic materials, organic matter or foreign substances.

The grading shall meet the following requirements when tested in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 inch	100
No. 4	0 - 25
No. 8	0 - 5
No. 200	0 - 2.0

The loss on abrasion will be determined in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of 9 percent at 100 revolutions.

Maximum loss of 40 percent at 500 revolutions.

The percent of carbonates in aggregate shall be a maximum of 30 when tested in accordance with the requirements of Arizona Test Method 238.

The percent of fractured coarse aggregate particles shall be a minimum of 70 when tested in accordance with the requirements of Arizona Test Method 212.

The Flakiness Index shall be a maximum of 25 when tested in accordance with the requirements of Arizona Test Method 233.

The Bulk Oven Dry Specific Gravity shall range from 2.30 to 2.85 when tested in accordance with the requirements of Arizona Test Method 210.

404-3 Construction Requirements:

404-3.01 Weather Limitations:

Bituminous material used in chip seal coats shall be applied to an existing bituminous surface only when the existing bituminous surface is dry and the pavement surface temperature is at least 85 degrees F.

Bituminous material used in prime coats shall normally be applied to an existing aggregate surface only when the ambient air temperature in the shade is at least 70 degrees F and when the existing aggregate surface is slightly damp.

Despite the required minimum surface temperature and surface condition, the Engineer, at any time, may require that work cease or that the work day be reduced in the event of weather conditions either existing or expected which would have an adverse effect upon the bituminous treatment.

404-3.02 Equipment:

(A) Distributor Truck:

Distributor trucks shall be so designed, equipped, maintained and operated that bituminous material at even heat may be applied uniformly on variable widths of surface up to 15 feet at readily determined and controlled rates of from 0.03 to one gallon per square yard, with uniform pressure, and with an allowable transverse variation from any specified rate not to exceed 10 percent or 0.02 gallons per square yard, whichever is less. Distributor equipment shall include a tachometer, pressure gauges, accurate volume measuring devices or a calibrated tank, and a thermometer for measuring temperatures of the tank contents. Distributors shall be equipped with a power unit for the pump and a spray bar which is adjustable laterally and vertically. The distributor shall provide for continuous circulation of the bituminous material through the tank and spray bar.

Prior to the spreading of bituminous material, all distributor trucks proposed for use shall have been tested within 12 months from the date of spreading to determine the rate of the transverse spread. The contractor shall furnish the Engineer with evidence that the distributor provides continuous circulation of the bituminous material through the tank and spray bar, and that the transverse spread of the distributor trucks, when the trucks were approved for use, was as uniform as practicable and under no conditions was there a variance on any of the test pads greater than the allowable transverse variation; however, the Engineer may require that each distributor truck be tested to determine the rate of the transverse spread.

The rate of transverse spread shall be determined in accordance with the requirements of Arizona Test Method 411.

Equipment which fails to provide an acceptable application of bituminous material shall be removed from the project.

(B) Power Brooms:

Power brooms shall be of the rotary type equipped, maintained and operated so that the bristles are of reasonably uniform length and capable of cleaning without gouging or tearing the surface.

(C) Rollers:

Rollers shall be of the oscillating type having a width of not less than four feet with pneumatic tires of equal size and diameter and with treads satisfactory to the Engineer. Wobble-wheel rollers will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be inflated to 90 pounds per square inch, or such lower pressure as designated by the Engineer, and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic-tired rollers shall be constructed so that the total weight of the compactor can be varied to produce an operating weight per tire of not less than 2,000 pounds. The total operating weight of the roller shall be varied as directed by the Engineer.

(D) Aggregate Spreaders:

Aggregate spreaders shall be self-propelled continuous feed units supported by at least four wheels equipped with pneumatic tires mounted on two axles.

Aggregate spreaders shall be equipped with positive controls so that the required amount of material will be deposited uniformly over the full width of the bituminous material. Aggregate application rates are expected to vary from four to 40 pounds per square yard, depending on the type of construction.

Where it is necessary to apply aggregate at a rate less than four pounds per square yard, other means such as a sand slinger may be used with the approval of the Engineer.

404-3.03 Traffic Control:

In the construction or application of a bituminous treatment, the treated roadway surface shall not be used by the contractor, its agents, or others until it has been definitely established to the satisfaction of the Engineer that it will not be damaged or marred under the action of traffic. No traffic of any description shall be allowed on any bituminous application until approved by the Engineer. The contractor shall erect and maintain approved barricades, signs and other traffic control devices and shall use every possible means to protect the work and to exclude traffic from the roadway surface for as long a time as may be required. Traffic shall be handled in the manner most convenient to the traveling public. When traffic is handled on a one-way basis, the contractor shall provide such flaggers and pilot trucks as deemed necessary to insure adequate protection for the roadway surface. Traffic may be detoured around the work, provided that detours are constructed and maintained in a satisfactory manner and properly signed. When it is necessary to provide for traffic across a bituminous treated surface, the crossing shall be blotted with material, as directed, before the crossing is opened to traffic.

404-3.04 Preparation of the Surface:

The surface to be treated shall be thoroughly cleaned prior to applying the bituminous material. The contractor shall inspect the surface to be treated and shall satisfy itself as to the extent of the cleaning work required and the type of equipment that will be necessary to clean the surface.

When the work consists of a chip seal coat or when blotter material is applied, self-propelled rotary power brooms along with hand brooms, if necessary, shall be used immediately in advance of applying the bituminous material.

When a bituminous treatment is to be applied to an existing aggregate surface, the surface shall be uniformly smooth, firm and reasonably true to grades and cross sections as shown on the project plans, and shall be so maintained throughout the placing of the bituminous treatment. In no event shall a bituminous treatment be placed on a soft, uneven base. Any holes, depressions or irregularities shall be repaired. All loose and unsuitable material shall be removed and replaced by suitable material, which shall be compacted to produce a dense surface conforming to the adjacent area. Uniformity of surface texture is of the utmost importance.

When required, the existing aggregate surface on which the bituminous treatment is to be placed shall be lightly bladed, watered and compacted immediately prior to the application of bituminous material. In extremely dry areas, additional light applications of water may be required prior to the application of the bituminous material to facilitate penetration of the bituminous material.

404-3.05 Application of Bituminous Material:

The types, grades, and approximate rates of application of bituminous material will be as specified herein.

The Engineer will specify the exact rates based on the surface to be treated and the characteristics of the aggregate material. The rates to be applied may vary substantially because of different surface conditions within the project limits. The actual bituminous material application shall not vary more than 10 percent from the specified application rate.

The bituminous material shall be uniformly applied to the prepared surface at the rate specified by the Engineer and in one application.

Bituminous materials shall be heated by a retort or steam coils in such a manner that steam will not be introduced directly into the bituminous material.

The various types or grades of bituminous materials shall be mixed with materials or applied at temperatures within the limits given in Table 1005-6, and at no time shall the contractor increase the temperature of the bituminous material above the higher limit specified.

When a chip seal coat is applied, the spray bars on the distributor truck shall be controlled by a boot man riding at the rear of the distributor where the operation of all sprays is in the boot man's full view.

In order to obtain uniform distribution, the distribution shall be promptly started or stopped at the junction of two applications in a manner that will not result in overlaps or gaps in the applications.

The distribution shall be promptly cut off prior to the decrease in uniform flow caused by the distributor tank becoming empty, when there is a decrease in uniform flow due to any reason whatever, or when the forward movement of the distributor slows down or stops.

In the event that any spots are missed in the application, or any areas develop that do not have a uniform spread or penetration, such areas shall be remedied without unnecessary delay as directed by the Engineer.

Care shall be taken to prevent the spraying or splattering of bituminous material on adjacent pavements, structures, curb, guardrail, trees and shrubbery or any other object outside of the area designated for spraying.

Unused bituminous material shall not be disposed of within the right-of-way lines.

404-3.06 Application of Cover Material:

Cover material shall be immediately and uniformly spread over the freshly applied bituminous material by means of a self-propelled, continuous feed aggregate spreader. Any oversize aggregate or foreign material picked up during stockpiling or loading operations shall be eliminated before entering the aggregate spreader hopper. Supplemental spreading and smoothing shall be done by hand methods where necessary.

When emulsified asphalt is used, the cover material shall be wet but free of running water at the time of spreading. When bituminous material other than emulsified asphalt is used,

the cover material, at the time of spreading, shall be at least as dry as the material dried to a saturated surface-dry condition in accordance with the requirements of Arizona Test Method 210.

404-3.07 Rolling Cover Material:

Following the spreading of cover material, the surface shall be promptly rolled with self-propelled pneumatic-tired compactors. A sufficient number of compactors shall be provided to cover the width of the material spread in one pass of the compactors and this rolling shall continue until a minimum of three passes has been completed.

404-3.08 Removing of Loose Cover Material:

All loose cover material shall be removed from the paved surface by brooming in not less than 12 hours nor more than 36 hours after application; however, if because of weather conditions, temperature or other reasons, the Engineer determines that conditions are not conducive to obtaining the best results, brooming shall be discontinued until the Engineer has considered all conditions and has determined the best time for the removal of the cover material. The cover material shall be removed by means of a power broom which shall be in good condition and of a design suitable for the work. The action of the broom shall be such that particles which are stuck to the bituminous material will not be dislodged.

404-3.09 Application of Blotter Material:

The approximate amount of blotter material, when required as a part of a bituminous treatment, will be specified in the Special Provisions; however, the Engineer will specify the exact rate to be applied based on the characteristics of the bituminous treated surface.

Blotter material, at the time of spreading, shall be at least as dry as material dried to a saturated surface dry condition in accordance with the requirements of Arizona Test Method 211.

Blotter material shall be uniformly spread by means of a sand slinger or other equipment approved by the Engineer. Any oversize aggregate or foreign material picked up during stockpiling or loading operations shall be eliminated before entering the spreader. Supplemental spreading or smoothing shall be done by hand methods where necessary.

Prior to final acceptance and when ordered by the Engineer, the contractor shall remove and dispose of any excess blotter material. The method of removal and the disposal of any excess blotter material shall be the contractor's responsibility.

404-3.10 Joints:

Transverse joints with the preceding work, at intersections, and at all existing pavements and structures shall be made by a method approved by the Engineer prior to the start of the work.

Longitudinal joints shall be butt joints.

Joints shall be cleaned as deemed necessary by the Engineer prior to the application of bituminous material in the adjacent strip.

Regardless of the width of the roadway to be sealed, the number of longitudinal joints shall be kept to a minimum and shall be located to the greatest degree possible so that they will coincide with painted lines between traffic lanes.

404-3.11 Prime Coat:

The type of bituminous material and the approximate application rate shall be as specified in the Special Provisions.

When it is deemed necessary, areas having excess bituminous material shall be blotted with material as directed.

When so directed, the surface of the completed prime coat shall be rolled with a pneumatic-tired roller.

The integrity of the prime coat shall be maintained at all times until the next course is placed or until final acceptance. In the event traffic has caused holes or breaks in the surface, such holes or breaks shall be satisfactorily repaired by the contractor.

404-3.12 Tack Coat:

Tack coat shall be applied to a primed surface, to an existing bituminous surface or to the surface between layers of bituminous mixed materials.

The material to be used for bituminous tack coat will be specified by the Engineer and shall conform to the requirements of Section 1005.

The type, grade or designation, and the rate of application for the specific usage will be specified by the Engineer. The following table shows the various types of material and the approximate application rates from which the Engineer may select the tack coat:

Type, Grade or Designation	Approximate Application Rates: Gallons / Square Yard		Payment Factor
	Prior to Placing ACFC	All Other Tack Coats	
Emulsified Asphalt (Special Type)		0.12	0.7
Emulsified Asphalt (Other than Special Type)		0.08	1.0
Asphalt Cement (Grade Specified)	0.06 to 0.08	0.06	1.0

by Engineer)			
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If emulsified asphalt of any designation or type is used it shall have broken before asphaltic concrete is placed. If held over night, the emulsified asphalt shall be reheated and agitated prior to further application.

The Engineer may either reduce the rate to be applied or eliminate the use of tack coat in any part of the work if, in the Engineer's judgment, the bituminous mixed material to be placed will be effectively bonded to the underlying surface; however, in the case of asphalt cement applied immediately prior to placing the asphaltic concrete friction course, the Engineer may adjust the rate to be applied within the stated limits.

Bituminous material shall be applied only as far in advance of the placement of the bituminous mixed materials as is necessary to obtain the proper condition of tackiness. In no event shall more bituminous material be applied in one day than will be covered by bituminous mixed materials during that same day.

404-3.13 Fog Coat:

The type of bituminous material and the approximate application rate shall be as specified in the Special Provisions. The material shall be diluted with one part water to one part bituminous material.

Blotter material shall be applied to the treated surface in one or more applications for a total application as specified in the Special Provisions at a time specified by the Engineer and before opening to traffic.

404-3.14 Chip Seal Coat:

The type of bituminous material shall be CRS-2. The approximate application rate shall be as specified in the Special Provisions.

Cover material shall be applied at the rate of approximately 0.01 cubic yards per square yard; however, the Engineer will specify the exact rate to be applied based on the characteristics of the aggregate material and the surface to be treated.

The contractor shall submit a minimum 75-pound sample of cover material to the Engineer at least 10 calendar days prior to beginning application of the cover material for testing.

Chip seal coat shall be placed between the dates specified in the Special Provisions.

The minimum traffic-free period for a newly applied chip seal coat shall be three hours; however, the contractor's hauling equipment may use the new seal coat during the traffic free period at a speed not to exceed 15 miles per hour. After the traffic free period, but prior to removing the loose cover material, all traffic allowed by the Engineer shall be limited to a speed not to exceed 25 miles per hour.

404-4 Method of Measurement:

Bituminous materials will be measured by the ton.

Bituminous material that is required to be diluted prior to application will be measured by the ton of diluted material.

Cover material, when specified, will be measured by the cubic yard. Cover material will be weighed, and the amount in tons of dry material will be converted to cubic yards. The weight of all moisture contained in the cover material will be deducted prior to the conversion of the weight in tons to the volume in cubic yards. The dry weight per cubic yard will be determined in accordance with the requirements of AASHTO T 19.

The specific gravity of cover material varies from one source to another. The contractor shall be responsible to determine the amount of cover material that will be required to complete the work from the source or sources from which the cover material is obtained.

Blotter material, when required, will be measured by the ton.

Measurement for payment will be made only for the quantity of bituminous material and for the quantity of aggregate material used in accordance with the requirements of these specifications.

Time to apply tack coat is defined as the hours within a work shift that an approved distributor truck containing the specified bituminous material is required by the Engineer to be at the work site.

The time which is required to apply tack coat will be measured to the nearest hour for the actual number of hours required in any one work shift; however, when the time required is less than four hours in any workday, the time will be measured as four hours.

404-5 Basis of Payment:

The accepted quantities of bituminous treatments, complete in place, measured as provided above, will be paid for at the contract unit price, except the contract unit price for liquid asphalt will be adjusted for quantities of material represented by the corresponding test results. Adjustments will be made in accordance with Table 1005-2.

For emulsified bituminous materials which have a specified minimum percent residue, the emulsified product incorporated into the work which does not meet this minimum will be subject to an adjustment, to the nearest cent, in the contract unit price. The adjusted unit price for material which does not meet this minimum will be determined by multiplying the contract unit price by the value, to the nearest hundredth, obtained by dividing the residue obtained by testing by the specified minimum residue.

Payment for all measures necessary to direct and escort traffic through the area being bituminous treated will be made as specified under Section 701.

No measurement or direct payment will be made for rolling.

No measurement or direct payment will be made for furnishing, applying and removing blotter material, furnished in conjunction with the application of a prime coat.

No measurement or direct payment will be made for the maintenance or repair of a prime coat surface.

The bidding schedule quantity for tack coat is based on an estimated application rate of 0.06 gallons per square yard for each application shown on the project plans.

The unit price for bituminous tack coat is deemed to be the cost to furnish, transport, and store asphalt cement or emulsified asphalt at the project location. Payment for bituminous tack coat will be made at the unit price multiplied by the respective payment factor listed under Subsection 404-3.12, and adjusted to the nearest dollar.

Unless otherwise specified, the accepted quantity of bituminous tack coat, measured as provided above, will be paid at the contract unit price per ton adjusted as provided above which price shall be full compensation for furnishing, transporting, and storing the exact type, grade or designation of bituminous tack coat specified by the Engineer.

Unless otherwise specified, the accepted quantity of time to apply bituminous tack coat, measured as provided above, will be paid for at the contract unit price per hour which payment shall be full compensation for applying bituminous tack coat.

SECTION 405 ROAD MIX BITUMINOUS PAVEMENT:

405-1 Description:

The work under this section shall include furnishing all materials and placing an aggregate material combined with a bituminous material, mixed and placed by the road mix method, to form a base or surface course or for other specified purposes in accordance with the details shown on the project plans and the requirements of these specifications.

405-2 Materials:

Aggregate shall conform to the requirements specified in the Special Provisions.

Bituminous material shall be liquid asphalt conforming to the requirements of Section 1005 for the grade specified in the Special Provisions.

405-3 Construction Requirements:

405-3.01 General:

Prior to placing road mix bituminous pavement over an existing bituminous surface or a primed base all loose dirt and other objectionable material shall be removed from the existing surface. If so directed, such cleaning shall be done with a rotary power broom.

Prior to placing road mix bituminous pavement over a base course the base surface shall be smooth and firm and in reasonably close conformity to the lines, grades and dimensions required and shall be so maintained throughout the period of placing the road mix bituminous pavement.

405-3.02 Placing Aggregate:

Aggregate shall be deposited upon the prepared base or existing pavement and shaped into uniform windrows or shall be uniformly spread by an approved spreading device in the amount necessary to provide a surface of the required width and thickness.

When a traveling mixing plant is used, the loose material shall be placed in windrows or in a blanket of uniform cross section and of such size that all the material in the windrow or blanket can be passed through the mixing plant at each mixing operation.

405-3.03 Application of Bituminous Material:

Bituminous material shall be applied to the aggregate at a temperature conforming to the range of temperatures specified in Table 1005-6.

Bituminous material shall be applied only when the atmospheric temperature in the shade is above 70 degrees F.

Application of bituminous material shall not be made when the aggregate contains more than 1.5 percent moisture; however, in special cases when the aggregate is unusually porous, a moisture content in excess of 1.5 percent may be permitted at the discretion of the Engineer.

The approximate amount of bituminous material to be used will be specified in the Special Provisions; however, the exact amount will be determined by the Engineer at the time of application.

The total bituminous material required shall be applied to the aggregate uniformly in two or more applications. Application shall conform to the requirements of Section 404.

405-3.04 Mixing:

(A) General Requirements:

The aggregate and the bituminous material shall be mixed by means of a motor grader or shall be mixed by means of a traveling mixing plant, supplemented by motor grader mixing,

(B) Motor Grader Mixing:

Immediately following each application of bituminous material, sufficient mixing shall be done to absorb partially the bituminous material and prevent the formation of pools. After the final quantity of bituminous material has been applied and the materials partially mixed, the entire volume of loose material shall be moved into a windrow in the center or side of the road. The windrow shall then be processed until all particles of the mixture are thoroughly and uniformly coated with bituminous material. During this operation the blade shall be set so as to cause a revolving motion of the mixture. The amount of mixing required will be determined on the basis of uniform color and consistency of the mixture.

(C) Traveling Plant Mixing:

The plant used for mixing shall be so constructed that it will readily and cleanly pick up all the aggregate without damage to the base and will feed the aggregate to the mixing chamber at a uniform rate. The bituminous material feed shall be readily adjustable and be mechanically synchronized with the flow of aggregate to the mixer. Manual controls of the flow of bituminous material will not be permitted. Each time mixing commences or ends, the starting or stopping of the bituminous material application shall be so timed as to avoid the formation of rich or lean spots in the mixture.

The materials shall be mixed until a uniform product is obtained with all particles of aggregate thoroughly coated with bituminous material.

405-3.05 Spreading:

The mixture shall be thoroughly aerated before spreading in order to reduce the solvents.

The completely mixed material shall be spread only by skilled operators. Spread lengths shall be limited in order that the finishing and compacting can be completed within the same day. The motor grader used to spread the mixture shall have a blade not less than 12 feet long, and a wheel base of not less than 16 feet, and shall be free from lost motion in the blade control. After spreading on the road bed, if necessary, the moisture content shall be reduced by blading and reblading the mixture and allowing it to dry before final spreading.

If the thickness of the material to be compacted is greater than two inches after spreading as specified above, approximately the upper one half of the material shall be removed and placed in windrows of equal size on each side. The windrows shall be so placed that earth or shoulder material will not become mixed with the windrowed material. The area between the windrows shall then be thoroughly rolled with pneumatic-tired rollers, after which the windrows shall be moved and the areas occupied by the windrows shall be rolled. Then the windrowed material shall be evenly spread over the lower compacted layer and shall be shaped and rolled to the finished grade and cross section.

Other methods of spreading the material may be used if approved by the Engineer.

405-3.06 Compacting:

Compacting equipment shall consist of pneumatic tired-compactors and tandem power (steel wheel) compactors. Compactors shall be self-propelled.

The position of the seat or seats or the placement of the mirrors shall be such as to enable the operator to have the edge of the pavement against which the bituminous road mix is being compacted in the operator's full view at all times.

At its option, the contractor may furnish either pneumatic-tired compactors of the type that are equipped with means for increasing or decreasing the air pressure in the tires while in operation or compactors of the conventional type.

Pneumatic tired compactors shall be designed so that they are capable of turning or reversing direction on the bituminous road mix surfaces without scuffing or displacing the material.

Steel wheel compactors shall weigh not less than eight tons and shall be rated according to the manufacturer's rating in tons.

Sufficient rolling equipment shall be furnished to compact and finish satisfactorily the amount of mixture being placed.

Rolling with pneumatic-tired rollers shall be continuous throughout the spreading operations.

Tandem power rollers shall be used for final compaction and finish rolling.

Final rolling shall be done longitudinally, beginning at the outer edge and progressing toward the center, except that on superelevated curves the Engineer may require that rolling progress from the lower to the upper edge. Under no circumstances shall the center of the road be rolled first.

Each passage of the roller shall overlap the preceding passage not less than one half the width of the roller. Rolling shall continue until the surface is smooth and uniformly and thoroughly compacted.

405-3.07 Surface Requirements and Tolerances:

An acceptable surface shall not vary more than 3/16 inch from the lower edge of a 10-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

When deviations in excess of the above tolerances are found, such places, as humps or depressions, shall be corrected.

405-3.08 Inaccessible Areas:

At locations where bituminous road mix is to be placed over areas inaccessible to conventional mixing, spreading or compacting equipment, the material may be mixed at other locations and spread and compacted by other approved methods.

405-4 Method of Measurement:

Road mix bituminous pavement will be measured by the ton for the mixture actually used, which will include the weight of aggregate and bituminous material. Measurement will include any weight used to construct intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks or other miscellaneous items or surfaces.

Bituminous material of the type specified will be measured by the ton in accordance with the requirements of Section 109.

Measurement for payment will be made only of the quantity of bituminous material used in accordance with the requirements of these specifications.

405-5 Basis of Payment:

The accepted quantities of road mix bituminous pavement, measured as provided above, will be paid for at the contract unit price per ton, which price shall be full compensation for the work complete in place, including compaction and necessary surface preparation.

Payment for bituminous material will be made by the ton. Adjustments in the contract unit price, in accordance with the requirements of Table 1005-7, will be made for the quantities of material represented by the corresponding test results.

SECTION 406 ASPHALTIC CONCRETE:

406-1 Description:

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture if required, and an asphalt cement to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

It is the intent of this specification that the contractor acquire and make all arrangements for a source or sources of material; that it furnish Certificates of Compliance as hereinafter specified; that it furnish a mix design which will meet the design criteria specified hereinafter; and that it provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

406-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor on the basis of the following criteria and tested in accordance with the requirements of the following test methods:

Criteria	Requirements	Arizona Test
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		3/4 inch Mix	Base Mix	Method
1.	Voids in Mineral Aggregate: %, Range	15.0 – 18.0	14.5 - 17.0	815
2.	Effective Voids: %, Range	Note (1)	Note (1)	815
3.	Absorbed Asphalt: %, Range	0 - 1.0	0 - 1.0	815
4.	Index of Retained Strength: %, Min. (2)	60	60	802
5.	Wet Strength: psi, Minimum	150	150	802
6.	Stability: pounds, Minimum	2,000	3,000	815
7.	Flow: 0.01 inch, Range	8 – 16	8 – 16	815
8.	Mineral Aggregate Grading Limits:			201
Sieve Size	Percent Passing			
	3/4 inch Mix		Base Mix	
	No Admix	Includes Admix	No Admix	Includes Admix
1-1/4 inch			100	100
1 inch	100	100	90 - 100	90 - 100
3/4 inch	90 - 100	90 - 100	85 - 95	85 - 95
1/2 inch	---	---	---	---
3/8 inch	62 - 77	62 - 77	57 - 72	57 - 72
No. 8	37 - 46	38 - 47	32 - 42	33 - 43
No. 40	10 - 18	11 - 19	8 - 16	9 - 17
No. 200	1.5 - 4.5	2.5 - 6.0	1.5 - 3.5	2.0 - 5.0
Notes:				
(1) As specified in the Special Provisions.				
(2) For Interstate roadways, if the average elevation of the project is above 3,500 feet, the Index of Retained Strength shall be a minimum of 70 percent.				

The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the range specified in the Special Provisions.

406-3 Materials:

406-3.01 Mineral Aggregate:

The contractor shall provide a source of material in conformance with the requirements of Section 1001. Sub-paragraph (3) regarding sampling and testing under Subsection 1001-4(B) is hereby deleted.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the mineral aggregate has been crushed. Any material inspected by the Department as crushed material for the project shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

The contractor may blend uncrushed fine aggregate up to a maximum of 15 percent of the total aggregate, provided that the composite of uncrushed fine aggregate and crushed fine aggregate meets the requirement for uncompacted void content. The uncrushed fine aggregate shall be 100 percent passing the 1/4 inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	Arizona Test Method 210 and 211	2.35 - 2.85
Combined Water Absorption	Arizona Test Method 210 and 211	0 - 2.5%
Sand Equivalent	AASHTO T 176	Minimum 55
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 85% with at least two fractured faces (plus No. 4 material)
Uncompacted Void Content	Arizona Test Method 247	Minimum 45%

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion

shall be performed separately on materials from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

Mineral aggregate from a source or combination of sources which does not meet the requirements, according to the contractor's mix design proposal, for combined bulk specific gravity and/or combined water absorption up to a maximum of 3.0 percent but meets other specified requirements will be further considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement content and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

406-3.02 Mineral Admixture:

When the mix design includes a mineral admixture, the amount used shall be 1.0 percent, by weight, of the mineral aggregate unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for Index of Retained Strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement or hydrated lime conforming to the following requirements.

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

406-3.03 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. The type of asphalt binder shall be as shown in the Special Provisions.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.17 ± 0.02 pascal-seconds, measured in accordance with ASTM D 4402. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.28 ± 0.03 pascal-seconds, measured in accordance with ASTM D 4402. The testing required in ASTM D 4402 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a

maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified by the asphalt binder supplier. The laboratory mixing and compaction temperature ranges shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report.

406-4 Mix Design:

Utilizing mineral aggregate which has been crushed, processed, separated and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate samples used for mix design purposes shall be representative of aggregate materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing.

The mix design shall be prepared by a mix design laboratory that has met the requirements of the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

The use of a mix design developed for a previous project which meets these specifications may be proposed by the contractor provided the methods of producing mineral aggregate have not changed since the development of the mix design, the asphalt cement and mineral admixture type and source of supply have not changed, the mix design test values meet all current specification requirements, and the previous use of the mix design was satisfactory to the Department. The Engineer will determine whether a previously used mix design can be approved for use based upon the evidence provided by the contractor of current stockpile gradations, fractured coarse aggregate particles, sand equivalent, and uncompacted void content, and the evidence provided by the contractor that the results obtained during production under the previously used mix design were satisfactory. Should the Engineer question the evidence provided or determine the previous use was not satisfactory, the contractor shall prepare and submit a new mix design in accordance with these specifications.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.

- (3) The supplier, refinery, type of asphalt cement and any modifiers including polymers, the source and type of mineral admixture, and the percentage of asphalt cement and mineral admixture to be used.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture if it is utilized.
- (6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, uncompacted void content, immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges.

The mix design shall be submitted in a format which clearly provides all the mix design requirements and be signed by a person authorized by the contractor to act in such matters on the contractor's behalf.

The mix design and representative samples of the mineral aggregate used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content at least five working days prior to the start of asphaltic concrete production. Collection of the samples provided by the contractor shall be witnessed by the Engineer, and the samples shall be representative of the materials produced. Additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified. The sand equivalent will be determined in accordance with the requirements of AASHTO T 176, the fractured coarse aggregate particles in accordance with Arizona Test Method 212 (plus No. 4 material with at least 2 fractured faces), and the uncompacted void content in accordance with Arizona Test Method 247. The sand equivalent determined by the Engineer must be at least 90 percent and not more than 110 percent of the value contained in the contractor's mix design, and meet the minimum requirements specified in Subsection 406-3.01. The fractured coarse aggregate particles and uncompacted void content determined by the Engineer shall meet the minimum requirements specified in Subsection 406-3.01. If the mineral aggregate fails to meet these requirements, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in its aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the contractor.

If the contractor elects to change its source of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. The self-directed target change must meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
GRADATION	
3/8 inch sieve	±2% from mix design target value
No. 8 sieve	±2% from mix design target value
No. 40 sieve	±1% from mix design target value
No. 200 sieve	None
Asphalt Cement Content	±0.2% from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

406-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in the Special Provisions.

406-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading and finishing of asphaltic concrete and for the applying of bituminous material, such as tack coats, prime coats and provisional seals, all in accordance with the appropriate portions of the specifications.

The contractor shall be responsible for the material spread rate and thickness control.

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 325 °F unless a higher temperature is recommended by the asphalt cement supplier and approved by the Engineer. A recording pyrometer or other approved thermometric

instrument sensitive to a rate of temperature change not less than 10 °F per minute shall be placed at the discharge chute of the drier so as to automatically record the temperature of the asphaltic concrete or mineral aggregate. A copy of the recording shall be delivered to the Engineer at the end of each shift of production.

If a mineral admixture is necessary to produce asphaltic concrete that meets the design criteria, the mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt cement. The Engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of aggregate and admixture.

If a conventional drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process. The mineral admixture shall be weighed across a weigh belt, or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the aggregate to fall through mixing blades onto a belt or chute are not acceptable. The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of aggregate feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates.

If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt cement. The system by which mineral admixture is incorporated into the production of asphaltic concrete at the pugmill shall be designed to minimize the loss of the mineral admixture.

The contractor's plant and equipment shall be capable of introducing admixture into the asphaltic concrete without significant loss of mineral admixture through the dust collection system of the plant. The method of introducing admixture into plant types other than a conventional drum mix or batch plant is subject to the approval of the Engineer.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

If a mineral admixture is used, a positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Pavers shall be equipped with an activated screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time the Engineer may require the work to cease or that the workday be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be wiped when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

406-7 Acceptance:

406-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted Void Content
- Gradation
- Asphalt Cement Content
- Effective Voids
- Stability
- Compaction
- Smoothness

**406-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and
Uncompacted Void Content of Mineral Aggregate:**

During asphaltic concrete production, the Engineer will obtain and test samples of mineral aggregate for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. The sample shall be obtained either from the cold feed belt prior to the addition of mineral admixture if used, or from the stockpiles. The sand equivalent will be determined by the Engineer in accordance with the requirements of AASHTO T 176, the fractured coarse aggregate particles in accordance with Arizona Test Method 212 (plus No. 4 sieve material with at least two fractured faces), and the uncompacted void content in accordance with Arizona Test Method 247. Mineral aggregate will be acceptable for sand equivalent when the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design. Mineral aggregate shall meet the minimum requirements for fractured coarse aggregate particles and for uncompacted void content specified in Subsection 406-3.01. If the mineral aggregate fails to meet these requirements, operations shall cease and the contractor shall have the options of submitting a revised mix design conforming to the requirements of Subsection 406-4 or correcting deficiencies in its aggregate stockpiles.

406-7.03 Blank:

406-7.04 Gradation, Asphalt Cement Content, Effective Voids, and Stability:

A lot shall be considered to be one shift's production. In the event a shift's production is less than 1200 tons, multiple shifts may be combined to form a lot. When a lot consists of production from more than one shift, the following conditions apply: at least one sample shall be taken each shift, at least one sample shall be taken every 500 tons, and no mix or target value changes shall be made within the lot. If changes are made in the mix design or target values, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one-half for 15 days. The material will be tested by the Engineer for asphalt cement content, gradation, Marshall density and stability, and maximum theoretical density. Asphalt cement content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace. Marshall density and stability, and maximum theoretical density shall be tested in accordance with the requirements of Arizona Test Method 416. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424, Section 2.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt cement content as measured by the ignition furnace testing and the actual asphalt cement content shall be determined. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt content may include weighing of asphalt cement deliveries, invoice weights, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used,

documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration be performed. If a difference of greater than 0.1 percent is determined between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, a correction to the asphalt cement value determined by ignition furnace testing shall be made. The correction, once documented and approved by the Engineer, may be applied to test results from up to and including the fifth day of asphaltic concrete production. The resulting correction factor shall be applied thenceforward. For other plants, no correction will be made to asphalt cement content values measured by ignition furnace.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after the time samples were obtained for that lot, the contractor may make a written request for additional testing of that lot. The additional testing shall be performed in an independent approved laboratory designated by the Engineer. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for Marshall density and stability, and maximum theoretical density in accordance with the requirements of Arizona Test Method 416. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424, Section 2. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt cement content by ignition furnace and gradation of the mineral aggregate. New PT's, will be determined for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace test value was made as specified above. The results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

A mixture properties lot placed with an average stability below 2500 pounds for base mixes, or 1750 pounds for 3/4 inch mixes shall be rejected, and shall be subject to an engineering analysis of anticipated performance in accordance with Subsection 406-9(E). Production shall cease until the contractor proposes a corrective action the Engineer finds acceptable. If the Engineer rejects the proposed corrective action, the contractor shall submit a revised mix design.

The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	LL	UL
Gradation (sieve size):		
3/8 inch (see Note 2 below)	TV - 6.0	TV + 6.0
No. 8	TV - 6.0	TV + 6.0

No. 40	TV - 5.0	TV + 5.0
No. 200	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.4	TV + 1.0
Notes: (1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV). (2) In the case of 3/8 inch sieve requirement, for the base mix only, the lower limit shall be the target value minus 8.0, and the upper limit shall be the target value plus 8.0.		

The Engineer will determine the PT of each measured characteristic using the procedure defined under "Definitions, Abbreviations and Formulas for Acceptance". Utilizing Table 406-2, the Engineer will then determine pay factors for each measured characteristic.

406-7.05 Compaction

(A) Courses 1-1/2 inch or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F. Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 degrees F.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. Pneumatic tired compactors shall be constructed so that the total weight of the

compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No.1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic tired compactors are used, will designate the tire pressure.

One pneumatic tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 °F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 °F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Courses Greater than 1-1/2 inch in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractors responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A lot for compaction purposes shall be identical to the lot described in Subsection 406-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 406-9(D). Each lot shall be tested for acceptance.

Ten samples shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate 10 random locations within the lot and the contractor shall take one core at each location. If more than one shift constitutes a lot, a minimum of three cores shall be taken each shift, or as directed by the Engineer. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. If rumble strips are formed by rolling indentations into the compacted pavement, the area of the pavement surface from one foot inside of the traffic lane edge of a rumble strip to the outside edge of a shoulder will be excluded from testing and material in that area will not be included in the compaction lot quantity; however, if rumble strips are placed in the compacted pavement by grinding, sawing, or milling, that area will not be excluded from testing, and material in that area will be included in the compaction lot quantity. Areas excluded from testing will be compacted in accordance with Subsection 406-705(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of 4 inches in diameter and shall be taken not later than two working days after the lot or subplot placement. The cores shall be delivered to the Engineer immediately upon being taken. The material will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the contractor within five working days of receipt of samples by the Engineer. In trench areas where more than one lift is placed, coring shall be accomplished through the full depth after the final lift is placed. The compaction density shall be based on the ten cores, each the full depth of the trench.

The target value shall be 98.0 percent of laboratory density. The laboratory density will be the average of the four laboratory densities determined in Subsection 406-7.04.

The Upper Limit (UL) is the Target Value (TV) plus 4.0 pounds per cubic foot and the Lower Limit (LL) is the Target Value (TV) minus 4.0 pounds per cubic foot. The Engineer will determine the PT for compaction using the procedure defined under "Definitions, Abbreviations and Formulas for Acceptance", and, utilizing Table 406-2, will determine the compaction pay factor.

406-7.06 Smoothness:

The final asphaltic concrete surface will be tested by the Engineer. The finished surface shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed in the longitudinal direction, or 1/4 inch when placed in the transverse direction across longitudinal joints. All deviations exceeding the specified tolerance shall be corrected by the contractor.

406-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and any necessary mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 406-7.04 for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results, unless a correction was made to the ignition furnace test value in Subsection 406-7.04, in which case no adjustment will be allowed.

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 406-6.

406-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total pay factors, each unit of asphaltic concrete will be included in two separate lots: a "mixture properties lot," and a "compaction lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable mixture properties lot pay factor and compaction lot pay factor.

The Engineer may exclude certain locations from the random sampling used in determining the mixture properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Blank:

(B) Mixture Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 406-7.04.
- (2) A single pay factor shall be determined for Gradation, and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.

- (3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed \$3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 406-9(E) shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 406-7.05(B).

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable mixture properties lot pay factor and compaction lot pay factor for each project shall be determined as follows:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 406-7.04, regardless of which project(s) the samples fall within.
- (2) PT values and pay factors for compaction, for those areas subject to Subsection 406-7.05(B), shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that subsection.
- (3) The mixture properties lot pay factor shall be determined separately for each project in accordance with Subsection 406-9(B), utilizing the individual pay factors determined in (1) above.
- (4) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 406-9(C), utilizing the pay factor determined in (2) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within ten working days after receiving notice that a mixture properties lot or a compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$3.00 per ton each for

mixture properties lots and compaction lots. Positive mixture pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place.

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected lot is submitted for referee testing by the contractor, the ten working days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at the contractor's expense and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factors, and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

- (1) The occurrence of two or more rejected lots within any ten concurrent lots.
- (2) The occurrence of three or more consecutive penalty lots.
- (3) The occurrence of five or more penalty and/or rejected lots within any ten consecutive lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 406-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design, or the course of action proposed in the engineering analysis, shall be implemented, and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

(G) Mineral Admixture:

If mineral admixture is used in the mix design it will be paid for at the predetermined price established in the Bidding Schedule. If mineral admixture is eliminated, it will be eliminated

in accordance with the requirements of Subsection 109.05; however, no reimbursement will be made for any costs which the contractor may have incurred in anticipation of its use.

DEFINITIONS, ABBREVIATIONS AND FORMULAS FOR ACCEPTANCE

Target Value (TV):

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design.

Average (AVE):

The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean. The average will be determined to one decimal place, except for asphalt cement content, which will be determined to two decimal places.

Standard Deviation (s):

The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE, divided by the number of test results minus one. This statement does not limit the methods of calculations of standard deviation; other methods which obtain the same value may be used. The standard deviation will be determined to two decimal places.

Upper Limit (UL):

The value above the TV of each measured characteristic which defines the upper limit of acceptable production.

Lower Limit (LL):

The value below the TV of each measured characteristic which defines the lower limit of acceptable production.

Upper Quality Index (QU):

$$Q U = \frac{U L - A V E}{s}$$

The QU will be calculated to three decimal places.

Lower Quality Index (QL):

$$Q L = \frac{A V E - L L}{s}$$

The QL will be calculated to three decimal places.

Percentage of Lot Within UL (PU):

Determined by entering Table 406-1a (for N = 4) or Table 406-1b (for N=10) with QU.

Percentage of Lot Within LL (PL):

Determined by entering Table 406-1a (for N=4) or Table 406-1b (for N=10) with QL.

Total Percentage of Lot Within UL and LL (PT):

$$PT = (PU + PL) - 100$$

Pay Factor (PF):

Determined by entering Table 406-2 with PT.

TABLE 406-1a DETERMINATION OF PU or PL Number of Tests "N" = 4			
QU or QL	PU or PL	QU or QL	PU or PL
1.485 or More	100	0.000 to -0.014	50
1.455 to 1.484	99	-0.015 to -0.044	49
1.425 to 1.454	98	-0.045 to -0.074	48
1.395 to 1.424	97	-0.075 to -0.104	47
1.365 to 1.394	96	-0.105 to -0.134	46
1.335 to 1.364	95	-0.135 to -0.164	45
1.305 to 1.334	94	-0.165 to -0.194	44
1.275 to 1.304	93	-0.195 to -0.224	43
1.245 to 1.274	92	-0.225 to -0.254	42
1.215 to 1.244	91	-0.255 to -0.284	41
1.185 to 1.214	90	-0.285 to -0.314	40
1.155 to 1.184	89	-0.315 to -0.344	39
1.125 to 1.154	88	-0.345 to -0.374	38
1.095 to 1.124	87	-0.375 to -0.404	37
1.065 to 1.094	86	-0.405 to -0.434	36
1.035 to 1.064	85	-0.435 to -0.464	35
1.005 to 1.034	84	-0.465 to -0.494	34
0.975 to 1.004	83	-0.495 to -0.524	33
0.945 to 0.974	82	-0.525 to -0.554	32
0.915 to 0.944	81	-0.555 to -0.584	31
0.885 to 0.914	80	-0.585 to -0.614	30
0.855 to 0.884	79	-0.615 to -0.644	29
0.825 to 0.854	78	-0.645 to -0.674	28
0.795 to 0.824	77	-0.675 to -0.704	27
0.765 to 0.794	76	-0.705 to -0.734	26
0.735 to 0.764	75	-0.735 to -0.764	25
0.705 to 0.734	74	-0.765 to -0.794	24

TABLE 406-1a DETERMINATION OF PU or PL Number of Tests "N" = 4			
QU or QL	PU or PL	QU or QL	PU or PL
0.675 to 0.704	73	-0.795 to -0.824	23
0.645 to 0.674	72	-0.825 to -0.854	22
0.615 to 0.644	71	-0.855 to -0.884	21
0.585 to 0.614	70	-0.885 to -0.914	20
0.555 to 0.584	69	-0.915 to -0.944	19
0.525 to 0.554	68	-0.945 to -0.974	18
0.495 to 0.524	67	-0.975 to -1.004	17
0.465 to 0.494	66	-1.005 to -1.034	16
0.435 to 0.464	65	-1.035 to -1.064	15
0.405 to 0.434	64	-1.065 to -1.094	14
0.375 to 0.404	63	-1.095 to -1.124	13
0.345 to 0.374	62	-1.125 to -1.154	12
0.315 to 0.344	61	-1.155 to -1.184	11
0.285 to 0.314	60	-1.185 to -1.214	10
0.255 to 0.284	59	-1.215 to -1.244	9
0.225 to 0.254	58	-1.245 to -1.274	8
0.195 to 0.224	57	-1.275 to -1.304	7
0.165 to 0.194	56	-1.305 to -1.334	6
0.135 to 0.164	55	-1.335 to -1.364	5
0.105 to 0.134	54	-1.365 to -1.394	4
0.075 to 0.104	53	-1.395 to -1.424	3
0.045 to 0.074	52	-1.425 to -1.454	2
0.015 to 0.044	51	-1.455 to -1.484	1
0.000 to 0.014	50	-1.485 or Less	0

TABLE 406-1b DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
2.176 or More	100	0.000 to -0.012	50
1.940 to 2.175	99	-0.013 to -0.038	49
1.798 to 1.939	98	-0.039 to -0.064	48
1.691 to 1.797	97	-0.065 to -0.090	47
1.603 to 1.690	96	-0.091 to -0.116	46
1.526 to 1.602	95	-0.117 to -0.142	45
1.458 to 1.525	94	-0.143 to -0.169	44
1.396 to 1.457	93	-0.170 to -0.195	43
1.339 to 1.395	92	-0.196 to -0.222	42
1.286 to 1.338	91	-0.223 to -0.248	41
1.236 to 1.285	90	-0.249 to -0.275	40
1.188 to 1.235	89	-0.276 to -0.302	39
1.143 to 1.187	88	-0.303 to -0.329	38

TABLE 406-1b DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
1.100 to 1.142	87	-0.330 to -0.356	37
1.058 to 1.099	86	-0.357 to -0.383	36
1.018 to 1.057	85	-0.384 to -0.411	35
0.980 to 1.017	84	-0.412 to -0.439	34
0.942 to 0.979	83	-0.440 to -0.467	33
0.906 to 0.941	82	-0.468 to -0.495	32
0.871 to 0.905	81	-0.496 to -0.524	31
0.836 to 0.870	80	-0.525 to -0.553	30
0.802 to 0.835	79	-0.554 to -0.582	29
0.769 to 0.801	78	-0.583 to -0.612	28
0.737 to 0.768	77	-0.613 to -0.642	27
0.705 to 0.736	76	-0.643 to -0.673	26
0.674 to 0.704	75	-0.674 to -0.704	25
0.643 to 0.673	74	-0.705 to -0.736	24
0.613 to 0.642	73	-0.737 to -0.768	23
0.583 to 0.612	72	-0.769 to -0.801	22
0.554 to 0.582	71	-0.802 to -0.835	21
0.525 to 0.553	70	-0.836 to -0.870	20
0.496 to 0.524	69	-0.871 to -0.905	19
0.468 to 0.495	68	-0.906 to -0.941	18
0.440 to 0.467	67	-0.942 to -0.979	17
0.412 to 0.439	66	-0.980 to -1.017	16
0.384 to 0.411	65	-1.018 to -1.057	15
0.357 to 0.383	64	-1.058 to -1.099	14
0.330 to 0.356	63	-1.100 to -1.142	13
0.303 to 0.329	62	-1.143 to -1.187	12
0.276 to 0.302	61	-1.188 to -1.235	11
0.249 to 0.275	60	-1.236 to -1.285	10
0.223 to 0.248	59	-1.286 to -1.338	9
0.196 to 0.222	58	-1.339 to -1.395	8
0.170 to 0.195	57	-1.396 to -1.457	7
0.143 to 0.169	56	-1.458 to -1.525	6
0.117 to 0.142	55	-1.526 to -1.602	5
0.091 to 0.116	54	-1.603 to -1.690	4
0.065 to 0.090	53	-1.691 to -1.797	3
0.039 to 0.064	52	-1.798 to -1.939	2
0.013 to 0.038	51	-1.940 to -2.175	1
0.000 to 0.012	50	-2.176 or Less	0

TABLE 406-2 MIXTURE PROPERTIES AND COMPACTION PAY FACTORS	
	Pay Factors (Dollars/Ton)

PT	Gradation and Asphalt Content	Effective Voids	Compaction
100	0.00	+1.00	+1.00
95-99	0.00	+0.50	+0.50
90-94	0.00	0.00	0.00
85-89	0.00	-0.25	-0.25
80-84	-0.25	-0.50	-0.50
75-79	-0.50	-0.75	-0.75
70-74	-0.75	-1.00	-1.00
65-69	-1.00	-1.25	-1.30
60-64	-1.50	-1.50	-1.75
55-59	-2.00	-2.00	-2.00
50-54	-2.50	-2.50	-3.00

SECTION 407 ASPHALTIC CONCRETE FRICTION COURSE:

407-1 Description:

Asphaltic Concrete Friction Course (hereinafter asphaltic concrete) shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of an aggregate material and a bituminous material to form a pavement course in accordance with the details shown on the project plans and the requirements of these specifications.

407-2 Asphaltic Concrete Mix Design:

Mix designs will be developed on the basis of and tested in accordance with the requirements of Arizona Test Method 814.

407-3 Materials:

407-3.01 Preliminary Sampling and Testing; Tentative Approval of Source:

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source in accordance with the requirements of Section 1001.

When the contractor selects a source, it shall notify the Engineer. The Engineer shall be satisfied that the source has been adequately investigated and that samples to be taken will be representative of the material to be used. The Engineer will witness samples taken by the contractor. Samples shall be at least 300 pounds.

The loss on abrasion will be determined in accordance with the requirements of AASHTO T 96. Loss on abrasion shall meet the following requirements:

Maximum loss of 9 percent at 100 revolutions.

Maximum loss of 40 percent at 500 revolutions.

The percent of carbonate in aggregate shall be maximum of 30 when determined in accordance with the requirements of Arizona Test Method 238.

The bulk oven dry specific gravity will be determined in accordance with the requirements of Arizona Test Method 210 and shall be a minimum of 2.30.

If the material meets the requirements for loss on abrasion, percent carbonate and bulk oven dry specific gravity, the source will be approved to that extent and will be acceptable for the development of a mix design.

407-3.02 Mineral Aggregate:

Mineral aggregate shall be separated into at least two stockpiles. No individual stockpile usage shall be less than three percent of the total mineral aggregate.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

407-3.03 Bituminous Material:

Asphalt cement shall be an asphalt binder performance grade PG 64-16, conforming to the requirements of Section 1005. Approximately six percent will be required; however, the exact amount will be specified by the Engineer.

407-3.04 Mineral Admixture:

Mineral admixture will be required. The amount used shall be 1.0 percent, by weight of the mineral aggregate. Mineral admixture shall be either portland cement, blended hydraulic cement, or hydrated lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

407-3.05 Mineral Aggregate Mix Design Grading Limits and Quality Characteristics:

The mix design grading limits shall be as follows:

Sieve Size	Percent Passing (Without Mineral Admixture)
3/8 inch	100
No. 4	35 – 55
No. 8	9 – 14
No. 200	0 - 2.5

The aggregate characteristics from the contractor-furnished source together with the proposed methods of producing mineral aggregate as described in Subsection 407-4 shall be such that the sand equivalent is at least 55 when tested in accordance with Arizona Test Method 242, the percent of fractured coarse aggregate particles is at least 85 (two fractured faces) when tested in accordance with Arizona Test Method 212, and the flakiness index is a maximum of 25 when tested in accordance with Arizona Test Method 233.

407-4 Contractor-Furnished Samples:

In addition to the mineral aggregate samples taken in accordance with the requirements of Subsection 407-3.01, the contractor shall furnish the Engineer samples of the bituminous material, mineral admixture, and any blend material from sources which will subsequently be used in the production of asphaltic concrete. Accompanying the samples shall be a letter from the contractor explaining in detail his proposed methods of producing mineral aggregate, including the expected wasting, washing, blending, proportioning, etc., to produce asphaltic concrete and any special or limiting conditions that the contractor may propose.

407-5 Mix Design Proposal and Testing:

Utilizing the contractor-furnished samples and consistent with the contractor's detailed proposal, the Engineer will determine if the contractor-furnished sources can produce asphaltic concrete meeting the requirements of Subsection 407-3.05. If the requirements of 407-3.05 are met the Department will, within 10 working days of receipt of all samples and the contractor's proposal by the Central Laboratory, provide the contractor with an approved mix design.

The approved mix design will specify the percent of material passing each required sieve with and without mineral admixture; the approximate percent of material to be used from each source; the type, source, and percent of bituminous material; the type and percent of mineral admixture; and any special treatment.

If the mineral aggregate does not meet the requirements of Subsection 407-3.05, the contractor shall take the necessary steps to provide material that does meet these requirements. Asphaltic concrete friction course production shall not begin until there is an approved mix design.

407-6 Previously Utilized Mix Design:

The contractor may propose to use an established mix design from a previously utilized source or a combination of sources. The contractor should then submit information

pertaining to the previously used design including evidence that the materials to be incorporated have not been changed. The Engineer will have the authority to disapprove the use of a previously utilized mix design if the Engineer questions the evidence provided or determines the prior use of the mix design did not obtain desirable results.

407-7 Changes in the Approved Mix Design During Production:

At any time after production of asphaltic concrete has been started on the basis of the approved mix design, changes may be proposed by the contractor or directed by the Engineer. If changes are made in the source of either bituminous material or mineral aggregate or changes are made in the proportions of mineral aggregate sources equal to or greater than five percentage points, additional testing, to the extent deemed necessary by the Engineer, will be performed in order that the Engineer may be satisfied that the mix design criteria will be met.

407-8 Time and Cost for Testing of Materials in Developing Mix Designs:

The Department will make a concerted effort to perform the required testing and to develop mix designs as quickly as possible. Up to 10 working days will be required to perform the required tests and to develop each mix design after the receipt of samples of all materials.

The number of working days established for the completion of the work includes 10 working days for the required testing and the developing of the approved mix design.

The contract time will be extended for no more than 10 working days, if necessary, to permit additional testing for the development of a mix design acceptable to the Department. After an approved mix design has been developed, the contract time will not be extended because of the time necessary to develop additional mix designs.

The costs associated with the testing of materials in the developing of mix designs after a mix design acceptable to the Department has been developed shall be borne by the contractor.

407-9 Acceptance of Materials:

407-9.01 General:

The contractor's attention is directed to the requirements of Subsection 105.13.

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified in Subsection 407-9.03 or because changes are made in the mix design, samples will be taken for calculating new consecutive averages either after production resumes or after the changes in the mix design have been made. The acceptance of the mineral aggregate gradation and the bituminous material content will be determined on the basis of the tests as specified in Subsection 407-9.03. The Engineer reserves the right to increase the frequency of sampling and testing upon the resumption of asphaltic concrete production.

407-9.02 Mineral Aggregate:

During asphaltic concrete production, the Engineer will obtain and test samples of mineral aggregate for determination of the sand equivalent, fractured coarse aggregate particles, and flakiness index. The sample shall be obtained from either the cold feed prior to addition of mineral admixture, or from the stockpiles. The sand equivalent shall be a minimum of 55 when tested in accordance with the requirements of Arizona Test Method 242. The percent of fractured coarse aggregate particles shall be at least 85 (two fractured faces) when tested in accordance with the requirements of Arizona Test Method 212. The flakiness index shall be a maximum of 25 when tested in accordance with the requirements of Arizona Test Method 233. Should such testing indicate results not meeting these requirements, operations shall cease and the contractor shall have the option of requesting a new mix design or correcting deficiencies in the aggregate stockpile.

Mineral aggregate will not be acceptable if clay balls, coated rock, or other deleterious materials are present.

407-9.03 Asphaltic Concrete:

(A) Mineral Aggregate Gradation:

For each approximate 500 tons of asphaltic concrete produced at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of Arizona Test Method 105 on a random basis just prior to the addition of mineral admixture and bituminous material. Samples will be taken by means of a sampling device which is capable of producing samples which are representative of the mineral aggregate. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance to the mix design gradation without mineral admixture in accordance with the requirements of Arizona Test Method 201. The gradation of the mineral aggregate will be considered to be acceptable unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests	
	3 Consecutive	One
No. 4	± 4	± 6
No. 8	± 4	± 6
No. 200	± 1.5	± 2.0

One hundred percent of the material shall pass the 3/8-inch sieve.

At any time that test results indicate that the gradation of the mineral aggregate does not fall within all of the limits indicated, the production of asphaltic concrete shall cease

immediately and shall not begin again until calibration tests indicate that the gradation is within the limits indicated.

(B) Bituminous Material Content:

For each approximate one-half shift, one sample of asphaltic concrete will be taken on a random basis in accordance with the requirements of Arizona Test Method 104, Section 2. The asphalt cement content shall be tested in accordance with the requirements of Arizona Test Method 421, using a nuclear asphalt cement content gauge. The amount determined will be compared with the amount specified in the mix design. Production of asphaltic concrete shall cease immediately and the plant recalibrated when the results of the average of three consecutive tests vary more than 0.40, or the result of any single test varies more than 0.60, from the mix design percent of bituminous material.

407-10 Construction Requirements:

407-10.01 Quality Control:

Quality control of mineral aggregate production and asphaltic concrete production shall be the responsibility of the contractor. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for the Engineer's own use.

407-10.02 Stockpiling:

When the total quantity of asphaltic concrete required can be produced in two successive eight hour shifts or less, sufficient mineral aggregate shall be stockpiled at the site of the hot plant to produce the quantity of asphaltic concrete required.

When the total quantity of asphaltic concrete required must be produced in more than two successive eight hour shifts, sufficient mineral aggregate shall be stockpiled at the site of the hot plant for at least two successive eight hour shifts of asphaltic concrete production; however, this requirement will be modified during the last two day's production, or under special conditions with the Engineer's approval.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

407-10.03 Proportioning:

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein. No fine material which has been collected in the dust collection system shall be returned to the mixture unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If so determined, the Engineer will authorize in writing the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are accurately and uniformly metered into the mixture.

The mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt cement. The Engineer may direct a spray of water be applied to control the loss of the mineral admixture.

If a drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The mineral admixture shall be weighed across a weigh belt, or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the aggregate to fall through mixing blades onto a belt or chute are not acceptable. The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of aggregate feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates. If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt cement. The system by which mineral admixture is incorporated into the production of asphaltic concrete shall be designed to minimize the loss of mineral admixture.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

A positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

Mineral aggregate, mineral admixture, and asphalt cement shall be proportioned by volume, by weight, or by a combination of volume and weight.

When mineral aggregate, mineral admixture, and asphalt cement are proportioned by weight, all receptacles and scales used for weighing or batching materials shall be insulated against the vibration or movement of the rest of the plant so that the error in weighing with the entire plant or any component part operating shall not exceed two percent for any setting or 1-1/2 percent for any batch. Bituminous material shall be weighed in a heated, insulated bucket suspended from a springless dial scale system.

When mineral aggregate, mineral admixture, and asphalt cement are proportioned by volume, the correct portion of each mineral aggregate size introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder which will supply the correct amount of mineral aggregate in proportion to the asphalt cement. The storage bins and continuous feeder shall be so arranged that the proportion of each mineral aggregate size can be separately adjusted. The continuous feeder for the mineral aggregate shall be mechanically or electrically actuated.

Unless approved by the Engineer, no individual stockpile usage shall be less than three percent of the total mineral aggregate.

407-10.04 Drying and Heating:

A recording pyrometer or other approved recording thermometric instrument sensitive to a rate of temperature change not less than 10 °F per minute shall be so placed at the discharge chute of the drier in order to record automatically the temperature of the asphaltic concrete or mineral aggregate and to facilitate reading the recorded temperature. A copy of the recording shall be given to the Engineer.

The moisture content of the asphaltic concrete shall not exceed one percent. The moisture content will be determined in accordance with the requirements of Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

407-10.05 Mixing:

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials.

A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 240 degrees F. If the asphaltic concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphaltic concrete will be minimized.

407-10.06 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

All wheels and tires of compactors and other equipment surfaces shall be wiped when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

The temperature of the asphaltic concrete just prior to compaction shall be at least 200 degrees F.

Unless otherwise specified on the project plans, asphaltic concrete shall not be placed on the two-foot widened section where guardrail is to be installed.

(1) Dates and Surface Temperature:

The contractor shall place asphaltic concrete only between the dates specified in the Special Provisions and only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85 degrees F.

Regardless of the surface temperature, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

(2) Delivery to Screed Unit:

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, migration of the bituminous material, crusts and lumps.

Should any one or more of such conditions be evident in the material delivered to the screed unit and which cannot be eliminated by one or more of the following methods, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the material in the condition as hereinbefore required:

- (a) Covering hauling units with tarpaulins.
- (b) Dumping material directly into the paver.
- (c) Moving the hot plant nearer to the point of delivery.

Other measures proposed by the contractor which will deliver asphaltic concrete meeting the above requirements will be considered by the Engineer.

(B) Loading Material into the Paving Machine:

If the asphaltic concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machines by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, it shall not be dumped at a distance greater than 150 feet in front of the paving machine. The loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing by Means of a Self-Propelled Paving Machine:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

In order to achieve, as far as practical, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant.

Self-propelled paving machines shall spread the mixture without segregation or tearing within the specified tolerances, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding eight feet in width, or widened sections not exceeding four feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impractical, asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternately, when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

Ski-type device at least 30 feet in length, supported throughout its entire length.

Short ski.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

407-10.07 Joints:

Longitudinal joints shall be located at the center line between two adjacent lanes.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of

asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

407-10.08 Compaction:

(A) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be static steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Compactors shall weigh not less than eight tons.

(B) Method:

A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

Compaction shall consist of a rolling sequence with specified types of compactors and the number of coverages as follows:

Rolling Sequence	Number of Coverages
Initial	1
Finish	1 - 2

A sufficient number of compactors shall be utilized so that at no time will the distance between the laydown machine and the initial rolling of the entire width of the mat being laid exceed 200 lineal feet.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated in accordance with the manufacturer's recommendations and with the number of coverages of the compactors as specified.

407-10.09 Compacting Miscellaneous Items and Surfaces:

Asphaltic concrete used in the construction of miscellaneous items and surfaces shall be compacted using compactors, hot-hand tampers, smoothing irons, mechanical vibrating hand tampers or with other devices to the extent considered necessary by the Engineer.

407-10.10 Surface Requirements and Tolerances:

Asphaltic concrete shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway, or 1/4 inch when placed in the transverse direction across longitudinal joints.

407-11 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, bituminous material, any necessary blending material, and mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, sidewalks, or other surfaces.

Asphalt cement will be measured by the ton.

Mineral admixture will be measured by the ton.

407-12 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price for the asphaltic concrete complete in place.

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

Payment for mineral admixture will be made by the ton.

SECTION 408 RECYCLED ASPHALTIC CONCRETE:

408-1 Description:

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling, and placing a mixture of new mineral aggregate material and salvaged pavement material together with bituminous material, and mineral admixture if necessary, to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

When the term "asphaltic concrete" is used hereinafter, it shall be deemed to mean asphaltic concrete which is a mixture of new mineral aggregate, salvaged pavement material, bituminous material, and if necessary, mineral admixture.

408-2 Asphaltic Concrete Mix Design Criteria:

Mix designs will be performed in accordance with Arizona Test Method 815, modified as necessary for recycled asphaltic concrete. Mix designs will be developed on the basis of and tested in accordance with the following test methods:

Criteria	Requirements	Arizona Test Method
Effective Voids: %,		

Criteria	Requirements	Arizona Test Method
Range for Mix Design Only	5.5 ± 0.5	416, Section 9
Index of Retained Strength: %, Minimum	(1)	802
Wet Strength: psi, Minimum	150	802
Stability: pounds, Minimum	2,000	815
Flow: 0.01 inches, Range	8 - 16	815
(1) See Special Provisions		

408-3 Materials:

408-3.01 Preliminary Sampling and Testing; Tentative Approval of Source:

There is no Department-furnished source of new mineral aggregate material. The contractor shall provide a source in accordance with the requirements of Section 1001.

When the contractor selects a source, it shall notify the Engineer. The Engineer shall be satisfied that the source has been adequately investigated and that samples to be taken will be representative of the material to be used. The Engineer will witness samples taken by the contractor. Samples shall be at least 300 pounds. A representative portion of the coarse material will be tested for loss on abrasion in accordance with the requirements of AASHTO T 96 and shall meet the following requirements:

Maximum loss of 9 percent at 100 revolutions.

Maximum loss of 40 percent at 500 revolutions.

If the material meets the requirements for loss on abrasion, the source will be approved to that extent and acceptable for the development of a trial mix design.

408-3.02 Mineral Aggregate:

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand or of sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

408-3.03 Mineral Admixture:

If the mix design requires a mineral admixture, approximately 1.0 percent, by weight, of the combined mineral aggregate and salvaged pavement material shall be used. Mineral admixture shall be either Portland cement or lime conforming to the following:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Portland Cement, Type IP	ASTM C 595
Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specifications shall be submitted.

408-3.04 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. The type of asphalt binder shall be as shown in the Special Provisions.

408-3.05 Mineral Aggregate; Stockpile Gradation and Quality Characteristics:

Mineral aggregate shall be separated into at least three stockpiles. The Engineer may approve the use of more than three stockpiles or approve changes to the specified stockpile gradations, provided the Engineer determines that a suitable composite gradation is obtainable. If more than three stockpiles are utilized, the grading of each stockpile will be specified by the Engineer. If mineral aggregate is separated into three stockpiles, the gradation of each stockpile shall be as follows:

Stockpile	Sieve Size	Percent Passing
Coarse	1 Inch	100
	3/4 Inch	75 - 100
	3/8 Inch	0 - 20
	No. 200	0 - 2.0
Intermediate	1/2 Inch	100
	3/8 Inch	80 - 100
	1/4 Inch	40 - 80
	No. 8	0 - 20
	No. 200	0 - 3.0
Fine	1/4 Inch	100
	No. 8	80 - 100
	No. 4	15 - 35
	No. 200	0 - 4.0 *
* In order to meet this gradation, washing of the fine material may be required.		

Mineral aggregate composited from the stockpiles in the mix design percentages shall be such that the sand equivalent is at least 55 when tested in accordance with the requirements of AASHTO T 176 and the percent of fractured coarse aggregate particles is at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

408-3.06 Salvaged Pavement Material; Stockpile Gradation:

Cores from the existing pavement will be taken, and information based on the testing of these cores in the laboratory may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

The existing pavement material shall be removed and processed through a mechanical crusher, in such a manner that all of the material will pass the maximum sieve size specified below, and there will be a minimum amount of fines. The Engineer reserves the right to waste obviously defective salvaged material or salvaged material that is not representative of the material used in the mix design. Unless otherwise shown on the plans or specified in the Special Provisions, material developed from milling ramps, crossroads, or other unrepresentative materials will be stockpiled separately by the contractor and not used in the recycled asphaltic concrete. All salvaged material not designated to be wasted or separated by the Engineer will be uniformly and continuously processed and separated into two stockpiles as follows:

Stockpile	Sieve Size	Percent Passing
Coarse	1-1/2 Inch	100
	3/8 Inch	0 - 25
Fine	3/4 Inch	100
	3/8 Inch	75 - 100

The material will be tested in accordance with the requirements of Arizona Test Method 240.

408-3.07 Mineral Aggregate and Salvaged Pavement Material Stockpile:

On the basis of samples of material from cores taken in the existing pavement structure, the proportions of mineral aggregate material from each stockpile and the proportion of salvaged material necessary to provide a mixture which is expected to meet the design criteria will be specified in the Special Provisions.

The exact percentage of material from each stockpile will depend upon the actual gradation of the new mineral aggregate in each stockpile and may vary from the amount indicated by as much as 10 percentage points. No additional payment will be made for changes in proportional use of mineral aggregate stockpiles within 10 percentage points of the targets specified.

The Engineer may direct a reduction in the percentage of salvaged pavement material used in order to obtain the specified design criteria or to obtain an acceptable gradation for the asphaltic concrete. The contractor will be reimbursed for the costs of additional mineral aggregate required in the asphaltic concrete should the percentage use of salvaged pavement material be reduced from the target specified.

408-4 Mix Design:

408-4.01 Trial Mix Design:

At least 15 working days prior to the production of asphaltic concrete, samples of the produced mineral aggregate stockpiles, including any blend material, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregates to be utilized in recycled asphaltic concrete production. The contractor shall furnish the Engineer with samples of at least 150 pounds of mineral aggregate from each stockpile and samples of the bituminous material to be utilized in the production of recycled asphaltic concrete. Accompanying the samples shall be a letter from the contractor detailing the source of asphalt cement; and the type and source of mineral admixture to be used, if required, and the method of adding it.

From the mineral aggregate samples furnished by the contractor and samples of existing pavement material taken by the Engineer, the Engineer will determine if asphaltic concrete meeting the specified mix design criteria can be produced.

The trial mix design will specify a composite mineral aggregate gradation, a single percentage to be used from each of the mineral aggregate stockpiles, a single percentage of salvaged pavement material from the combined use of both salvaged pavement stockpiles, and the percent of bituminous material. If a mineral admixture is necessary, the mix design will also specify the composite gradation of the mineral aggregate, including mineral admixture. The anticipated gradation of the salvaged material will also be specified. The mix design will specify the anticipated gradation of the combined mineral aggregate and salvaged pavement materials; or if mineral admixture is used, the anticipated gradation of the combined mineral aggregate and salvaged pavement materials including mineral admixture.

408-4.02 Initial Mix Design:

During the first full shift of asphaltic concrete production, the Engineer will test the material for Effective Voids, Stability, and Flow. Samples will also be tested for conformity with the anticipated gradation of the combined materials and the percent of bituminous material in accordance with the requirements of Arizona Test Method 402.

Asphaltic concrete will be considered satisfactory and production may continue if the mix design criteria for flow and stability have been met; the effective voids of the mix is between 3.0 and 7.0 percent; the percent of bituminous material, based on the average of three consecutive tests, does not vary more than 0.60 from the anticipated extraction target; and the gradation, based on the average of three consecutive tests, does not vary from the trial mix targets as follows:

Passing Sieve	Allowable Limit
No. 8	± 6
No. 40	± 6
No. 200	± 2.0

If the mixture meets these criteria, the trial mix design will be deemed to be the approved initial mix design. If the mix design criteria are not met, or if the gradation varies more than the allowable limits, the Engineer reserves the right to stop the work for a period of two working days to perform additional testing. The Engineer will then furnish the contractor

with a new mix design which will be deemed to be the approved initial mix design. During the time that the recycled asphaltic concrete operation is stopped, asphaltic concrete meeting the requirements of Section 406 may be produced. Delays caused by this work stoppage are not compensable.

The approved initial mix design will specify a composite mineral aggregate gradation, a single percentage to be used from each of the mineral aggregate stockpiles, and the percent of bituminous material. A single percentage of salvaged pavement material will be specified; the actual percentage use of each of the salvaged stockpiles will be determined by the Engineer on the basis of the relative weight of salvaged material produced for each stockpile. If a mineral admixture is necessary, the mix design will also specify the composite gradation of the mineral aggregate including mineral admixture. The anticipated gradation of the salvaged material will also be specified. The mix design will specify the anticipated gradation of the combined mineral aggregate and salvaged pavement materials; or if mineral admixture is used, the anticipated gradation of the combined mineral aggregate and salvaged pavement materials including mineral admixture.

408-5 Changes in Initial Mix Design During Production:

During the production of asphaltic concrete, the Engineer may order that changes be made in the approved initial mix design to meet the mix design criteria. The percent of material used from any one aggregate stockpile or the total percent of salvage material will not change more than five percentage points from the initial mix design.

Once an initial mix design has been approved by the Engineer, the costs associated with testing additional recycled mix design proposals requested by the contractor shall be borne by the contractor.

408-6 Acceptance of Materials:

408-6.01 General:

The contractor's attention is directed to the requirements of Subsection 105.13, Removal of Unacceptable and Unauthorized Work.

408-6.02 Mineral Aggregate:

At the direction of and witnessed by an authorized representative of the Engineer, the contractor shall secure one representative sample of each day's production from each stockpile. This sample will be composited to the specified stockpile percentages by the Engineer. The sand equivalent shall be a minimum of 55 when tested in accordance with the requirements of AASHTO T 176 and the percent of fractured coarse aggregate particles shall be at least 30 when tested in accordance with the requirements of Arizona Test Method 212.

The stockpiled material will not be acceptable if clay balls, coated rock, or other deleterious material are present.

For each approximate 1,000 tons of asphaltic concrete produced at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of Arizona Test Method 105 on a random basis just prior to the addition of mineral admixture and bituminous material, and prior to combining with the salvaged material. Samples will be taken by means of a sampling device which is capable of obtaining samples which are representative of the mineral aggregate. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 1,000 tons, at least one sample will be taken.

Samples will be tested for conformance with the mix design mineral aggregate gradation without mineral admixture in accordance with the requirements of Arizona Test Method 201. The gradation of the mineral aggregate will be considered to be acceptable unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests	
	Three Consecutive	One
3/8 inch and larger	± 6	± 8
No. 8	± 4	± 6
No. 40	± 4	± 6
No. 200	± 1.5	± 2.0

One hundred percent of the material shall pass the largest sieve size shown in the stockpile gradings.

At any time that test results indicate that the gradation of the mineral aggregate does not fall within all of the limits indicated, the production of asphaltic concrete shall cease immediately and shall not begin until calibration tests indicate that the gradation is within the limits indicated.

408-6.03 Bituminous Material Content:

The contractor shall provide an accurate method of determining the actual amount of bituminous material being incorporated into the mix. Production of asphaltic concrete shall not commence until calibration tests indicate that the method utilized is accurate. The Engineer may require recalibration of the bituminous delivery system at any time or when the results of the average of three consecutive extraction tests indicate a variation from the anticipated combined bituminous content by more than 0.60 percent.

408-6.04 Salvaged Pavement Material:

At the direction of and witnessed by an authorized representative of the Engineer, the contractor shall secure a representative sample of each day's production from each stockpile. This sample will be tested by the Engineer.

If the material does not conform to the specified stockpile grading, production of salvaged material stockpiles will cease until the contractor has corrected its stockpiling operations.

408-7 Construction Requirements:

408-7.01 Quality Control:

Quality control shall be the responsibility of the contractor. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for the Engineer's own use.

408-7.02 Stockpiling:

When the total quantity of asphaltic concrete required can be produced in two successive eight-hour shifts or less, sufficient mineral aggregate shall be stockpiled at the site of the hot plant to produce the quantity of asphaltic concrete required.

When the total quantity of asphaltic concrete required must be produced in more than two successive eight-hour shifts, sufficient mineral aggregate shall be stockpiled at the site of the hot plant for at least one eight-hour shift of asphaltic concrete production; however, these requirements will be modified during the last two day's production, or under special conditions with the Engineer's approval.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

Salvaged pavement material shall be separated and stockpiled as described in Subsection 408-3.06 so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided. The belts to the coarse and fine stockpiles shall either have weight totalizers to give proportioning information on the quantity of material from each stockpile or the contractor shall provide an alternate method approved by the Engineer to provide proportioning information.

408-7.03 Proportioning:

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein. The contractor shall provide documentation by calibration charts or other approved means that the mineral aggregate, salvaged pavement material, bituminous material, and mineral admixture, if used, are being proportioned in accordance with the approved mix design.

If a mineral admixture is necessary to produce asphaltic concrete that meets the design criteria, the mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt cement. The Engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of aggregate and admixture.

If a drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The mineral admixture shall be weighed across a weigh belt or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The

mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the aggregate to fall through mixing blades onto a belt or chute are not acceptable.

The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of aggregate feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates. If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt cement.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

If a mineral admixture is used, a positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If the Engineer so determines, the Engineer will authorize in writing the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are accurately and uniformly metered into the mixture.

Mineral aggregate, salvaged pavement material, mineral admixture, and bituminous material shall be proportioned by weight, or by a combination of volume and weight.

When mineral aggregate, salvaged pavement material, mineral admixture, and bituminous material are proportioned by weight, all boxes, hoppers, buckets or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the rest of the plant due to the operation of any equipment so that the error in weighing with the entire plant operating shall not exceed two percent for any setting nor one and one-half percent for any batch. Bituminous material shall be weighed in a heated, insulated bucket suspended from a springless dial scale system.

When mineral aggregate, salvaged pavement material, mineral admixture, and bituminous material are proportioned by volume, the correct portion of each mineral aggregate size and salvaged pavement material introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder which will supply the correct amount of mineral aggregate and salvaged pavement material in proportion to the bituminous material and so arranged that the proportion of each mineral aggregate size and salvaged pavement

material can be separately adjusted. The continuous feeder for the mineral aggregate and salvaged pavement material shall be mechanically or electrically actuated.

408-7.04 Drying and Heating:

A recording pyrometer or other approved recording thermometric instrument sensitive to a rate of temperature change of not less than 10 degrees F per minute shall be so placed at the discharge chute of the drier in order to record automatically the temperature of the asphaltic concrete or mineral aggregate and to facilitate reading the recorded temperature. A copy of the recording shall be given to the Engineer.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed one percent. The moisture content will be determined in accordance with the requirements of Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

408-7.05 Mixing:

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials. Mixing shall continue until the uniformity of coating is as high as can reasonably be achieved considering the character of the mixture.

A positive signal system shall be provided to indicate the low level of mineral aggregate and salvaged pavement material in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 325 °F. If the asphaltic concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphaltic concrete will be minimized.

408-7.06 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

All wheels and tires of compactors and other equipment shall be wiped when necessary with a product approved by the Engineer in order to prevent the picking up of the asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.

The base or subgrade upon which the asphaltic concrete is to be placed shall be prepared in accordance with the applicable requirements for the material involved and maintained in a smooth and firm condition until placement. Asphaltic concrete shall not be placed on a frozen or excessively wet base or subgrade.

Asphaltic concrete placed in nominal thicknesses of 1-1/2 inches or less shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F. Nominal thicknesses greater than 1-1/2 inches shall be placed only when the ambient temperature is at least 45 degrees F and rising and placement shall be stopped when the ambient temperature is 50 degrees F and falling.

At any time the Engineer may require that the work cease or that the work day be reduced in the event of weather conditions either existing or expected which would have an adverse effect upon the asphaltic concrete.

All asphaltic concrete shall be placed either as a leveling course or as a surfacing course. Leveling courses are defined as courses placed for the primary purpose of raising an existing paved or unpaved surface to a smooth plane. Surfacing courses are defined as courses placed to serve either as the traffic surface or as a surface upon which a finishing course or seal coat is to be placed.

The thickness of leveling and surfacing courses will be shown on the project plans. No change in thickness will be allowed without the written approval of the Engineer.

Succeeding lifts of asphaltic concrete shall not be placed on any asphaltic concrete that has not been accepted by the Engineer.

(B) Loading Asphaltic Concrete into the Paving Machine:

If the asphaltic concrete is dumped from the hauling vehicles directly into the paving machine, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machines by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, it shall not be dumped at a distance greater than 150 feet in front of the paving machine. The loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing Asphaltic Concrete by Means of Self-Propelled Paving Machines:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

In order to achieve, as far as practical, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant.

Self-propelled paving machines shall spread the mixture without segregation or tearing within the specified tolerances, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding eight feet in width or widened sections not exceeding four feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impractical, all courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternately when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

Ski-type device at least 30 feet in length, supported throughout its entire length.

Short ski.

500 feet of control line and stakes.

Joint matcher shoe.

The control line shall be set and maintained taut by the contractor to the grade and alignment established by the Engineer.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

408-7.07 Joints:

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the center line between two adjacent lanes. Joints shall be formed by a slope shoe or hot lapped, and shall result in a smooth uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

When surfacing courses are placed on ten foot or wider shoulders that are to receive rumble strips, any longitudinal joint between the shoulder and the travel lane shall be located at the travel lane edge of the rumble strip.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

408-7.08 Compaction:

(A) Courses 1-1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic-tired and steel wheel and shall be approved by the Engineer.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall

be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure.

Pneumatic tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic-tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverages using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	2 - 6 *	2 - 4 *
Finish	Static Steel	Static Steel	1 - 3	1 - 3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction, and when pneumatic-tired compactors are used, will designate the tire pressure.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 220 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors ballasted and operated as specified and with the number of coverages of the compactors as specified.

(B) Courses Greater Than 1-1/2 Inches in Nominal Thickness:

(1) General:

Asphaltic concrete immediately behind the laydown machine shall be a minimum of 275 degrees F.

Compaction shall be as specified in this Subsection except that if the Engineer determines the conditions of any portion of the paving, such as widenings, intersections, tapers and turnouts, not to be conducive to the procedures of this subsection, Subsection 408-7.08(A) will apply.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

Asphaltic concrete placed in nominal thicknesses greater than 1-1/2 inches shall be compacted until 80 percent of the lot, measured as hereinafter specified, is within the Upper and Lower Limits specified. Compaction control shall be the responsibility of the contractor. Selection of the number and types of rollers sufficient to meet the specified density requirements shall be the responsibility of the contractor. The contractor shall monitor its compaction compliance through testing of density and comparison to laboratory compacted specimens. Records of density testing, comparisons to laboratory density, and necessary adjustments to compaction operations shall be maintained. This requirement shall in no way relieve the contractor of the responsibility to provide an acceptable product as set forth elsewhere in the specifications.

(2) Compaction Acceptance Procedure:

A lot shall consist of one day's production. Each lot will be tested for acceptance. If changes are made in the mix design, new lots will be established.

Ten cores shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however, the outside one foot of an unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. If rumble strips are formed by rolling indentations into the compacted pavement, the area of the pavement surface from one foot inside of the traffic lane edge of a rumble strip to the outside edge of a shoulder will be excluded from testing; however, if rumble strips are placed in the compacted pavement by grinding, sawing, or milling, that area will not be excluded from testing. Areas excluded from testing will be compacted in accordance with Subsection 408-708(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than the working day following the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the contractor within three working days of receipt of cores by the Engineer. In trench areas where more than one lift is placed, coring shall be accomplished through the full depth after the final lift is placed. The compaction density shall be based on the ten cores, each the full depth of the trench.

The Target Value (TV) for compaction compliance shall be 98.0 percent of laboratory density. The laboratory density shall be the average of three (3) laboratory densities determined on random samples taken from the same day's production and in accordance with the requirements of Arizona Test Method 416.

The Upper Limit (UL) is the Target Value (TV) plus 4.5 pounds per cubic foot and the Lower Limit (LL) is the Target Value (TV) minus 4.5 pounds per cubic foot. These limits are used in statistical calculations for Quality Index. The Engineer will determine the acceptability of compaction utilizing the following definitions, formulas, and Table 408-1.

DEFINITIONS, ABBREVIATIONS AND FORMULAS FOR COMPACTION ACCEPTANCE

Target Value (TV):

The target value for compaction.

Average (AVE.):

The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean. The average will be determined to one decimal place.

Standard Deviation (s):

The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE., divided by the number of test results minus one. This statement does not limit the methods of calculations. Other methods which obtain the same value may be used. The standard deviation will be determined to two decimal places.

Upper Limit (UL):

The value above the target value for compaction which defines the upper limit of acceptable compaction.

Lower Limit (LL):

The value below the target value of compaction which defines the lower limit of acceptable compaction.

Upper Quality Index (QU):

$$QU = \frac{UL - AVE}{s}$$

The QU will be calculated to three decimal places.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

The QL will be calculated to three decimal places.

Percentage of Lot within UL (PU):

Determined by entering Table 408-1 with QU.

Percentage of Lot within LL (PL):

Determined by entering Table 408-1 with QL.

Total Percentage of Lot Within UL and LL (PT):

$$PT = (PU + PL) - 100$$

Should the contractor, during any five consecutive lots of production, fail to meet the specified density requirements for more than two lots, work shall cease. The contractor shall examine all aspects of its compaction procedures and implement all corrective actions necessary to obtain compaction. Work may resume for one shift of production during which time the contractor will demonstrate its ability to meet the compaction requirements. In the event the contractor fails to meet the compaction requirements during this one shift of production, the work shall again cease. At that time the Engineer will evaluate the specified compaction requirements. For purposes of evaluation, the Engineer may require the construction of a compaction test section. The test section will consist of not more than one day's production during which the Engineer will direct the compaction operations, including the size, type, sequencing and number of passes of each roller, the mix temperature, and the rate of production. Based upon the Engineer's evaluation of the compaction requirements, the Engineer will determine if the specified compaction requirements are attainable. Should the Engineer determine that the specified requirements are not attainable, revised requirements will be established which set forth a new target value and/or percent of lot compliance. The contractor will proceed on the basis of the Engineer's determination. Material which fails to meet the requirements for compaction will be evaluated in accordance with Subsection 105.04. No additional payment will be made for the costs associated with the procedures set forth herein, including the construction of test sections.

408-7.09 Compacting Miscellaneous Items and Surfaces:

Asphaltic concrete used in the construction of curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks or other similar miscellaneous items or surfaces shall be compacted using compactors, hot hand tampers, smoothing irons, mechanical vibrating hand tampers or with other devices to the extent considered necessary by the Engineer.

408-7.10 Surface Requirements and Tolerances:

All courses of asphaltic concrete shall be compacted as required, smooth and reasonably true to the required lines, grades, and dimensions.

Leveling course surfaces shall not vary more than 1/4 inch from the lower edge of a 10-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

Surfacing course surfaces shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway or 1/4 inch when placed in the transverse direction across longitudinal joints.

408-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, salvaged pavement material, bituminous material, and any necessary mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks or other miscellaneous items or surfaces.

Bituminous material will be measured by the ton.

Mineral admixture will be measured by the ton.

408-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided in Subsection 408-8, will be paid for at the contract unit price complete in place.

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

If mineral admixture is used in the mix design it will be paid for at the predetermined price established in the Bidding Schedule. If mineral admixture is eliminated, it will be eliminated in accordance with the requirements of Subsection 109.05, however, no reimbursement will be made for any costs which the contractor may have incurred in anticipation of its use.

TABLE 408-1 DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
2.176 or More	100	0.000 to - 0.012	50
1.940 to 2.175	99	- 0.013 to - 0.038	49
1.798 to 1.939	98	- 0.039 to - 0.064	48
1.691 to 1.797	97	- 0.065 to - 0.090	47
1.603 to 1.690	96	- 0.091 to - 0.116	46
1.526 to 1.602	95	- 0.117 to - 0.142	45
1.458 to 1.525	94	- 0.143 to - 0.169	44

TABLE 408-1
DETERMINATION OF PU or PL
Number of Tests "N" = 10

QU or QL	PU or PL	QU or QL	PU or PL
1.396 to 1.457	93	- 0.170 to - 0.195	43
1.339 to 1.395	92	- 0.196 to - 0.222	42
1.286 to 1.338	91	- 0.223 to - 0.248	41
1.236 to 1.285	90	- 0.249 to - 0.275	40
1.188 to 1.235	89	- 0.276 to - 0.302	39
1.143 to 1.187	88	- 0.303 to - 0.329	38
1.100 to 1.142	87	- 0.330 to - 0.356	37
1.058 to 1.099	86	- 0.357 to - 0.383	36
1.018 to 1.057	85	- 0.384 to - 0.411	35
0.980 to 1.017	84	- 0.412 to - 0.439	34
0.942 to 0.979	83	- 0.440 to - 0.467	33
0.906 to 0.941	82	- 0.468 to - 0.495	32
0.871 to 0.905	81	- 0.496 to - 0.524	31
0.836 to 0.870	80	- 0.525 to - 0.553	30
0.802 to 0.835	79	- 0.554 to - 0.582	29
0.769 to 0.801	78	- 0.583 to - 0.612	28
0.737 to 0.768	77	- 0.613 to - 0.642	27
0.705 to 0.736	76	- 0.643 to - 0.673	26
0.674 to 0.704	75	- 0.674 to - 0.704	25
0.643 to 0.673	74	- 0.705 to - 0.736	24
0.613 to 0.642	73	- 0.737 to - 0.768	23
0.583 to 0.612	72	- 0.769 to - 0.801	22
0.554 to 0.582	71	- 0.802 to - 0.835	21
0.525 to 0.553	70	- 0.836 to - 0.870	20
0.496 to 0.524	69	- 0.871 to - 0.905	19
0.468 to 0.495	68	- 0.906 to - 0.941	18
0.440 to 0.467	67	- 0.942 to - 0.979	17
0.412 to 0.439	66	- 0.980 to - 1.017	16
0.384 to 0.411	65	- 1.018 to - 1.057	15
0.357 to 0.383	64	- 1.058 to - 1.099	14
0.330 to 0.356	63	- 1.100 to - 1.142	13
0.303 to 0.329	62	- 1.143 to - 1.187	12
0.276 to 0.302	61	- 1.188 to - 1.235	11
0.249 to 0.275	60	- 1.236 to - 1.285	10
0.223 to 0.248	59	- 1.286 to - 1.338	9
0.196 to 0.222	58	- 1.339 to - 1.395	8
0.170 to 0.195	57	- 1.396 to - 1.457	7
0.143 to 0.169	56	- 1.458 to - 1.525	6
0.117 to 0.142	55	- 1.526 to - 1.602	5
0.091 to 0.116	54	- 1.603 to - 1.690	4
0.065 to 0.090	53	- 1.691 to - 1.797	3
0.039 to 0.064	52	- 1.798 to - 1.939	2

TABLE 408-1 DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
0.013 to 0.038	51	- 1.940 to - 2.175	1
0.000 to 0.012	50	- 2.176 or Less	0

SECTION 409 ASPHALTIC CONCRETE (MISCELLANEOUS STRUCTURAL):

409-1 Description:

Asphaltic concrete shall consist of furnishing all materials, mixing, hauling, and placing a mixture of aggregates, mineral admixture, and bituminous material to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and as directed by the Engineer.

Asphaltic concrete shall be produced from commercial sources or from any source approved by the Engineer. The contractor may produce asphaltic concrete using a mix design previously utilized by the Department provided the Engineer is satisfied that the mix design values and proposed aggregate gradation are suitable for the intended use and that the methods of producing mineral aggregate and asphaltic concrete have remained consistent since the development of the mix design.

409-2 Materials:

409-2.01 Aggregate:

Aggregate for asphaltic concrete shall have a loss on abrasion of not more than nine percent at 100 revolutions when tested in accordance with AASHTO T 96. The aggregate shall be crushed and processed to the following grading limits such that the sand equivalent is at least 55 when tested in accordance with the requirements of AASHTO T 176, and that the percent fractured coarse aggregate particles of the plus No. 4 sieve material is at least 50 when tested in accordance with the requirements of Arizona Test Method 212. The gradation will be determined in accordance with the requirements of Arizona Test Method 201.

Percent Passing (Including Mineral Admixture)		
Sieve Size	Lift Thickness Less Than or Equal to Two Inches	Lift Thickness Greater Than Two Inches
1 Inch		100
3/4 Inch	100	90 - 100
1/2 Inch	90 - 100	---
3/8 Inch	70 - 85	70 - 85
No. 8	42 - 52	42 - 52
No. 200	3.0 - 6.5	3.0 - 6.5

409-2.02 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. The type of asphalt binder shall be as shown in the Special Provisions.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.17 ± 0.02 pascal-seconds, measured in accordance with ASTM D 4402. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.28 ± 0.03 pascal-seconds, measured in accordance with ASTM D 4402. The testing required in ASTM D 4402 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified by the asphalt binder supplier. The laboratory mixing and compaction temperature ranges shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report.

409-2.03 Mineral Admixture:

Mineral admixture shall be either Portland cement or lime conforming to the following:

Material	Specification Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

The mineral admixture content shall be 2.0 percent, by weight, of the mineral aggregate, unless the contractor submits test information showing a lowered percentage of mineral admixture produces mix design results which the Engineer finds acceptable.

A Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specifications shall be submitted.

409-2.04 Mix Design:

Mix designs shall be developed by the contractor on the proposed mineral aggregate composited within the specified grading limits. The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing. The mix design shall be prepared by a mix design laboratory that has met the requirements of the Department's System for the Evaluation of Testing Laboratories. The requirements may be obtained from the Materials Group, 1221

North 21st Avenue, Phoenix, Arizona, 85009-3740. The mix design shall be submitted to the Engineer for review a minimum of 5 working days prior to the start of production. The mix design shall meet the following criteria when tested in accordance with the requirements of the following test methods:

Criteria	Requirement	Arizona Test Method
1. Voids in Mineral Aggregate: %, Range	14.5 - 18.5	815
2. Effective Voids: %, Range	5.5 - 6.5	815

The Engineer reserves the right to adjust the asphalt content during production from the mix design value without additional compensation to the contractor in order to obtain desirable effective voids. The Engineer may waive the requirements for a mix design if the intended use of the material is temporary in nature.

409-2.05 Sampling and Testing:

Sampling and testing the materials or mixture for quality control purposes shall be the contractor's responsibility. The Engineer reserves the right to sample and test the materials and mixture when necessary to determine that the materials and mixture reasonably conform to the requirements specified herein.

409-3 Construction Requirements:

409-3.01 General:

All courses of asphaltic concrete shall be compacted as required, smooth and reasonably true to the required lines, grades, and dimensions.

Leveling course surfaces shall not vary more than 1/4 inch from the lower edge of a 10-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

Surfacing course surfaces shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway, or 1/4 inch when placed in the transverse direction across longitudinal joints.

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein.

The temperature of the asphaltic concrete upon discharge from the mixer shall not exceed 325 °F.

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 °F.

Just prior to being placed, the asphaltic concrete shall be in a thoroughly mixed condition, free of lumps and crusts and at such a temperature as to be in a free flowing, workable condition.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Pavers shall be equipped with a activated screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material and tacked in accordance with the requirements of Subsection 404-3.12.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course. Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

409-3.02 Compaction:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		Number of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	2 - 6*	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F. Steel wheel compactors shall weigh not less than eight tons.

Initial and intermediate compaction shall be completed before the temperature of the asphaltic concrete falls below 200 degrees F. All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified and with the number of coverages of the compactors as specified.

409-3.03 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

409-4 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of aggregate, bituminous material, and mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strip, sidewalks or other miscellaneous items or surfaces.

409-5 Basis of Payment:

409-5.01 General:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton for the bituminous mixture complete in place.

No direct payment will be made for the bituminous material and mineral admixture in the asphaltic concrete, or the bituminous material for tack coat and application of tack coat, the price being considered as included in the price paid for asphaltic concrete.

Asphaltic concrete may be measured, by volume, upon the execution of a supplemental agreement which will specify the manner in which the volume is determined. The volume will include the volume of aggregate, bituminous material, mineral admixture and any necessary blending material.

409-5.02 Reduction for Noncompliance:

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement that do not meet the requirements of Section 1005 as determined by corresponding test results. Adjustments in payment will be made in accordance with the requirements of Table 1005-1 and the following formula:

$$R = (100 - P) \times \left| \frac{(\$200) \times (T)}{100} \right|$$

Where:

- R = Amount of Reduction in Payment (dollars)
- T = Quantity of asphalt cement in failure (tons, rounded to nearest tenth)
- P = Percent of Contract Unit Price allowed (Table 1005-1)

SECTION 410 ASPHALT-RUBBER STRESS-ABSORBING MEMBRANE:

410-1 Description:

The work under this section shall consist of furnishing all materials including asphalt-rubber, tack coat and cover material and applying the materials in accordance with the details shown on the project plans and the requirements of these specifications.

410-2 Materials:

410-2.01 Tack Coat:

The existing roadway surface upon which the Asphalt Rubber Membrane is to be placed, shall be first cleaned of potentially detrimental material and tacked with a light coat of bituminous material, conforming to the requirements of Subsection 404-3.12 of the specifications. The cleaning of the surface, the tacking of the surface and the type and amount of bituminous material used shall be as directed by the Engineer.

410-2.02 Asphalt-Rubber:

Asphalt-Rubber shall conform to the requirements of Section 1009. The type of asphalt-rubber shall be as shown in the Special Provisions. The rubber gradation shall be Type A.

410-2.03 Cover Material:

Cover material shall conform to the requirements of Subsection 404-2.02(C). The bulk specific gravity shall be 2.30 to 2.85 as determined in accordance with the requirements of Arizona Test Method 210. The gradation shall meet the following requirements when tested in accordance with Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 inch	100
1/4 inch	0 - 15
No. 8	0 - 5
No. 200	0 - 2.0

410-3 Construction Requirements:

410-3.01 General:

All equipment used to mix and apply asphalt-rubber material shall meet the requirements specified under Subsection 404-3.02(A) of the specifications. The equipment shall also be capable of maintaining a uniform, homogeneous mixture throughout the operation.

410-3.02 Application of the Asphalt-Rubber Stress-Absorbing Membrane:

Asphalt-Rubber Stress-Absorbing Membranes shall be placed between the dates specified in the Special Provisions.

The existing pavement shall be cleaned in accordance with the requirements of Subsection 404-3.04.

After cleaning and prior to the application of the membrane, the existing pavement surface shall be treated with a tack coat as hereinbefore specified.

Placement of the asphalt-rubber membrane shall be made only when all of the following conditions are met:

- (1) The ambient air temperature and the pavement surface temperature are both above 65 degrees F.
- (2) The pavement is dry.
- (3) The wind conditions are such that a satisfactory membrane can be achieved.
- (4) All construction equipment such as asphalt rubber distributor, aggregate spreader, haul trucks with cover material, and rollers are in position and ready to commence placement operations.

The distributor shall be capable of spreading the asphalt-rubber mixture in accordance with the tolerances specified in Subsection 404-3.02(A) except that the maximum deviation from the specified rate shall not exceed 0.05 gallons per square yard.

The hot asphalt-rubber mixture shall be applied at the rate of approximately 0.55 ± 0.05 gallons per square yard (based on a unit weight of 7.75 pounds per gallon of hot asphalt-rubber); however, the Engineer will specify the exact rate based on existing surface conditions.

All transverse joints shall be made by placing building paper over the end of the previous application, and the joining application shall start on the building paper. Once the application process has progressed beyond the paper, the paper shall be disposed of as directed by the Engineer.

All longitudinal joints shall be lapped approximately four inches.

Traffic shall not be permitted on the asphalt-rubber membrane prior to the application of cover material.

410-3.03 Application of Cover Material:

Cover material shall be applied in accordance with the requirements of Subsection 404-3.06.

Cover material shall be immediately and uniformly spread over the freshly applied asphalt-rubber at the rate of approximately 0.014 cubic yards per square yard; however, the actual rate of application will be determined by the Engineer.

Cover material shall be precoated with 0.40 to 0.60 percent asphalt cement, by weight of the aggregate, and shall have a minimum temperature of 250 degrees F at the time of application. The asphalt cement shall meet the requirements of Section 1005. The end result shall be a thoroughly and uniformly coated, dust free material.

410-3.04 Rolling:

At least three pneumatic rollers shall be provided to accomplish the required rolling. The rollers shall conform to the requirements of Subsection 406-7.05(A)(2), except that the minimum air pressure in each tire shall be 100 pounds per square inch.

A sufficient number of rollers shall be furnished to cover the width of the spread on the first pass and complete the required number of passes within the time specified hereinafter. The first pass shall be made immediately behind the spreader and if the spreading is stopped for any reason, the spreader shall be moved ahead so that all cover material may be immediately rolled. The rolling shall continue until a minimum of four complete coverages have been made. Final rolling shall be completed in accordance with the following:

Existing Pavement Temperature	Complete Rolling Within
100 °F and above	20 Minutes
Between 65 and 100 °F	10 Minutes

410-3.05 Traffic:

Traffic of all types shall be kept off the stress-absorbing membrane until it has had time to set properly. The minimum traffic free period shall be three hours. However, when it is absolutely necessary that hauling equipment or piloted traffic travel on the newly applied membrane and the use is approved in advance by the Engineer, the speed shall not exceed 15 miles per hour. Stress-absorbing membrane operations shall be scheduled so that the normal flow of traffic will be resumed before sunset.

410-3.06 Removing Loose Cover Material:

Loose cover material shall be removed in accordance with the requirements of Subsection 404-3.08. Sweeping shall be completed and all excess cover material removed prior to the placement of any subsequent layers of asphaltic concrete.

410-3.07 Placement of Asphaltic Concrete:

If the asphalt-rubber membrane has been subjected to traffic, a tack coat, as hereinbefore specified, shall be applied at the rate of approximately 0.06 gallons per square yard prior to placement of the asphaltic concrete.

410-4 Method of Measurement:

Asphalt-rubber material will be measured by the ton. Conversion from volume to weight will be calculated on the basis of 7.75 pounds per gallon of hot asphalt-rubber material.

Cover material will be measured by the cubic yard. Cover material will be weighed and the amount in tons of dry material will be converted to cubic yards. The weight of all moisture contained in the cover material will be deducted prior to the conversion of the weight in tons to the volume in cubic yards. The dry weight per cubic foot will be determined in accordance with the requirements of AASHTO T 19.

The quantities of bituminous tack coat and time to apply tack coat will be measured in accordance with the requirements of Section 404.

410-5 Basis of Payment:

The accepted quantity of asphalt-rubber, measured as provided above, will be paid for at the contract unit price for the asphalt-rubber mixture complete in place, including asphalt cement and crumb rubber.

The accepted quantity of cover material, measured as provided above, will be paid for at the contract unit price, complete in place, including precoating material, and rolling and removal of loose cover material.

The accepted quantities of bituminous tack coat and time to apply tack coat will be paid for in accordance with the requirements of Section 404.

The bidding schedule reflects a quantity of bituminous tack coat based on two applications of emulsified asphalt at the specified rate. No adjustment in the contract unit prices will be made because of a variation in the quantities actually required to complete the work.

SECTION 411 ASPHALTIC CONCRETE FRICTION COURSE (MISCELLANEOUS):

411-1 Description:

Asphaltic Concrete Friction Course, hereinafter asphaltic concrete, shall consist of furnishing all materials, mixing, hauling and placing a mixture of aggregates and bituminous material to form a pavement course in accordance with the details shown on the project plans and as directed by the Engineer.

Asphaltic concrete shall be produced from commercial sources or any source approved by the Engineer.

411-2 Materials:

411-2.01 Aggregate:

Aggregate for asphaltic concrete shall have a loss on abrasion of not more than nine percent at 100 revolutions when tested in accordance with AASHTO T 96. The aggregate shall be crushed and processed to the following grading limits such that the sand equivalent is at least 45; the percent of fractured coarse aggregate particles is at least 70, and the flakiness index is a maximum of 25. The sand equivalent, percent of fractured coarse aggregate particles, and the flakiness index will be determined in accordance with the requirements of Arizona Test Methods 242, 212, and 233, respectively. The gradation will be determined in accordance with the requirements of Arizona Test Method 201.

Sieve Size	Percent Passing
3/8 Inch	100
No. 4	35 - 60
No. 8	10 - 18
No. 200	0 - 4.0

411-2.02 Bituminous Material:

Asphalt cement shall be an asphalt binder performance grade PG 64-16, conforming to the requirements of Section 1005. Approximately six percent will be required; however, the exact amount will be specified by the Engineer.

411-2.03 Proportions:

The asphalt cement content will be specified by the Engineer and will be appropriate with the characteristics of the aggregate furnished from which the asphaltic concrete is to be produced.

411-2.04 Sampling and Testing:

Sampling and testing the materials or mixture for quality control purposes shall be the contractor's responsibility. The Engineer reserves the right to sample and test the materials and mixture when necessary to determine that the materials and mixture reasonably conform to the requirements specified herein.

411-3 Construction Requirements:

411-3.01 General:

Mixing plants shall conform to the requirements of AASHTO M 156, except as modified herein. Just prior to being placed, the asphaltic concrete shall be in a thoroughly mixed condition, free of lumps and crusts and at such a temperature as to be in a free flowing, workable condition.

The surface upon which the asphaltic concrete is to be placed shall be cleaned of all objectionable material and tacked with a light coat of bituminous material. The cleaning of the surface, the tacking of the surface and the type and amount of bituminous material used shall be as directed by and acceptable to the Engineer.

The contractor shall place asphaltic concrete only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85 degrees F. However, regardless of the surface temperature, the Engineer may require that the work cease or that the work day be reduced in the event that weather conditions, either existing or expected, are anticipated to have an adverse effect upon the asphaltic concrete.

The temperature of the asphaltic concrete just prior to compaction shall be at least 200 degrees F.

The asphaltic concrete shall be placed, using approved equipment and methods, to the lines and grades shown on the project plans and as directed by the Engineer.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

411-3.02 Compaction:

Compaction shall be accomplished by the use of self-propelled compactors and shall follow immediately behind the laydown machine and shall be completed with the least amount of effort.

Compaction shall be accomplished in such a manner that the surface requirements and tolerances specified herein will be met.

Compactors may be tandem power (steel wheel), vibratory steel wheel, or a combination of the above. Vibratory steel wheel rollers shall be operated in a static condition. The number of compactors to be furnished shall be adequate to accomplish the required compaction while the material is in a workable condition.

Steel wheel and vibratory steel wheel compactors shall be self-propelled and shall be operated with the drive wheel in the forward position.

Steel wheel compactors shall weigh not less than eight tons.

411-3.03 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

411-4 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of aggregate and bituminous material. Measurement will include any quantity used in construction of intersections, turnouts, curbs, spillways and spillway inlets, ditches, catch basin entrances, median strips, sidewalks, or other miscellaneous items or surfaces.

411-5 Basis of Payment:

411-5.01 General:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton for the bituminous mixture complete in place.

No direct payment will be made for the bituminous material in the asphaltic concrete, or the bituminous material for tack coat and application of tack coat, the price being considered as included in the price paid for asphaltic concrete.

Asphaltic concrete may be measured, by volume, upon the execution of a supplemental agreement which will specify the manner in which the volume is determined. The volume will include the volume of aggregate and bituminous material.

411-5.02 Reduction for Noncompliance:

A reduction in payment to the contractor for asphaltic concrete will be made for quantities of asphalt cement that do not meet the requirements of Section 1005 as determined by corresponding test results. Adjustments in payment will be made in accordance with the requirements of Table 1005-1 and the following formula.

$$R = (100 - P) \times \left| \frac{(\$200) \times (T)}{100} \right|$$

Where:

R	=	Amount of Reduction in Payment (dollars)
T	=	Quantity of asphalt cement in failure (tons, rounded to nearest tenth)
P	=	Percent of Contract Unit Price allowed (Table 1005-1)

SECTION 412 PAVEMENT FABRIC INTERLAYER:

412-1 Description:

The work under this section shall consist of furnishing and placing a pavement fabric and applying an asphalt binder coat between pavement layers or beneath a pavement overlay to provide a waterproofing and stress relieving membrane within the pavement structure, in accordance with the details shown on the project plans and the requirements of these specifications.

412-2 Materials:

412-2.01 Pavement Fabric:

The pavement fabric shall be supplied in accordance with and conform to the material requirements of Subsections 1014-1 and 1014-2.

412-2.02 Asphalt Binder Coat:

The asphalt binder coat is used to bond or tack the fabric to the pavement and perform a sealant function, providing a barrier to moisture infiltration. The bituminous material for the binder coat shall be an asphalt cement conforming to the requirements of Section 1005. The grade to be used shall be PG 64-16 or PG 70-10 as directed by the Engineer. The use of cutback or emulsion asphalts will not be allowed.

412-2.03 Blotter Material:

Blotter material shall meet the requirements of Subsection 404-2.02(B).

412-2.04 Fabric Packaging, Handling and Storing:

The identification, packaging, handling and storing of the geotextile fabric shall be in accordance with ASTM D 4873. Fabric rolls shall be furnished with suitable wrapping for protection against moisture and extended ultraviolet exposure prior to placement. Each roll shall be labeled or tagged to provide product identification sufficient to determine the product type, manufacturer, quantity, lot number, roll number, date of manufacture, shipping date, and the project number and name to which it is assigned. Rolls will be stored on the site or at another identified storage location in a manner which protects them from the

elements. If stored outdoors, they shall be elevated and protected with a waterproof cover. At no time, shall the fabric be exposed to ultraviolet light for a period exceeding seven days.

412-3 Construction Requirements:

412-3.01 Weather Limitations:

Neither the asphalt binder coat nor fabric shall be placed when weather conditions, in the opinion of the Engineer, are not suitable. For placement of the asphalt binder coat, the minimum air and pavement temperature shall be 50 degrees F and rising. Air and pavement temperature shall also be sufficient to allow the asphalt binder coat to hold the fabric in place.

412-3.02 Equipment:

(A) Asphalt Distributor Truck:

The asphalt distributor truck shall meet the minimum requirements of Subsection 404-3.02(A). The asphalt distributor truck shall be capable of spraying the asphalt binder coat at the application rate as approved by the Engineer. No streaking, skipping or dripping will be permitted. The distributor truck shall also be equipped with a hand spray attachment having a single nozzle and positive shut-off valve.

(B) Fabric Handling Equipment:

Mechanical or manual laydown equipment shall be capable of laying the fabric smoothly.

(C) Miscellaneous Equipment:

Stiff bristle brooms or squeegees to smooth the fabric, scissors or blades to cut the fabric, and brushes for applying asphalt at fabric overlaps shall be provided. Pneumatic rolling equipment to smooth the fabric into the asphalt binder, sanding equipment to apply a blotter sand, and brooming equipment may be required by the Engineer to improve the installation procedure. Refer to Subsections 404-3.02(B), (C), and (D) for equipment requirements.

412-3.03 Surface Preparation:

The pavement surface on which the fabric is to be placed shall be cleaned to remove all dirt, water, oil and any vegetation or debris.

412-3.04 Application of the Asphalt Binder Coat:

The asphalt binder coat shall be uniformly spray applied to the prepared dry pavement surface by means of the asphalt distributor truck at the rate of 0.25 gallons per square yard or as recommended by the fabric manufacturer and as approved by the Engineer. Some underlying surfaces may require a higher or lower application rate. A test strip may be necessary to determine the proper application rate.

Application of the asphalt binder coat shall be primarily by the distributor truck spray bar with hand spraying kept to a minimum. Temperature of the asphalt binder coat shall be sufficiently high to permit a uniform spray pattern. The minimum temperature of asphalt in the distributor tank shall be 290 degrees F. However, to avoid damage to the fabric, the asphalt temperature in the tank shall not exceed 325 degrees F.

The target width of the asphalt binder application shall be the width of the pavement fabric plus six inches. The asphalt binder shall be applied only as far in advance of the fabric installation as is appropriate to insure a tacky binder surface at the time of the fabric placement. Fabric shall be placed the same workshift as the asphalt binder coat is applied. Traffic shall not be allowed on the asphalt binder coat. Excess asphalt or spills shall be cleaned from the road surface to avoid flushing and fabric movement.

412-3.05 Fabric Placement:

The fabric shall be placed, with the heat bonded side up, on the asphalt binder coat using mechanical or manual laydown equipment capable of providing a smooth installation of the fabric with a minimum amount of wrinkling or folding. Placement of the fabric will take place prior to the time when the asphalt binder coat has cooled enough to start losing its tackiness. Wrinkles or folds which remain in the fabric and are large enough to be folded over 1/2 inch or more shall be slit and laid flat into the binder coat. Slit folds or wrinkles shall be shingle-lapped in the direction of the paving operation. Brooming and/or pneumatic rolling will be required to maximize fabric contact with underlying pavement surface.

Overlap of fabric joints shall be a minimum of three inches to insure full closure of the joint, but shall not exceed six inches. Transverse joints shall be lapped in the direction of paving to prevent edge pickup by the paver. Longitudinal joints shall be located in the same manner as normal pavement joints according to Subsection 406-6. A second application of hand-placed asphalt binder may be required at laps and repairs as determined by the Engineer to ensure proper binding of the narrow double fabric layer.

All areas with fabric placed shall be paved the same workshift. No vehicles or equipment except necessary construction equipment as approved by the Engineer and emergency vehicles will be allowed to drive on the fabric.

Removal and replacement of any fabric that is damaged will be the responsibility of the contractor.

412-3.06 Application of Blotter Materials:

Blotter material may be spread over asphalt-saturated fabric, if approved by the Engineer, to facilitate movement of equipment during construction or to prevent tearing or delamination of the fabric. If blotter sand is applied, excess quantities shall be removed from the fabric prior to placing the asphaltic concrete.

412-3.07 Placement of the Asphalt Concrete:

All areas where fabric has been placed shall be paved with asphaltic concrete during the same workshift. Placement of the asphaltic concrete shall closely follow fabric lay down. The temperature of the asphaltic concrete when delivered shall not exceed 325 degrees F. In the event that asphalt binder coat bleeds through the fabric causing construction problems before the overlay is placed, the affected areas shall be blotted by spreading blotter sand. Excess sand shall be removed before beginning the paving operation. In the event of a rainfall on the fabric prior to the placement of the asphaltic concrete, the fabric must be allowed to dry completely before the asphalt concrete is placed. To avoid movement or damage to the fabric during the paving operation, the turning of the paver and other vehicles shall be gradual and kept to a minimum.

412-4 Method of Measurement:

The pavement fabric interlayer will be measured by the square yard, in-place.

Bituminous material that is required for the asphalt binder coat will be measured by the ton.

Time to apply the asphalt binder coat is defined as the hours within a work shift that an approved distributor truck containing the specified bituminous material is required by the Engineer to be at the work site.

The time which is required to apply the asphalt binder coat will be measured to the nearest hour for the actual number of hours required in any one work shift; however, when the time required is less than four hours in any work day, the time will be measured as four hours.

412-5 Basis of Payment:

The accepted quantities of pavement fabric, measured as provided above, will be paid for at the contract unit price per square yard which price shall be full compensation for furnishing all labor, materials, and equipment, and performing all operations in connection with placing the pavement fabric interlayer as shown on the project plans and as specified and described herein.

The accepted quantities of bituminous material for the asphalt binder coat complete in place, measured as provided above, will be paid for at the contract unit price per ton, except that adjustments in the contract unit price, in accordance with the requirements of Table 1005-1, will be made for the quantities of material represented by the corresponding test results.

Payment for all measures necessary to direct and escort traffic through the area where the pavement fabric is being placed will be made as specified under Section 701.

No measurement or direct payment will be made for pneumatic rolling or brooming which is required or at the direction of the Engineer.

No measurement or direct payment will be made for furnishing, applying and removing sand blotter material which may be required by the Engineer.

The accepted quantity of time to apply the asphalt binder coat, measured as provided above, will be paid for at the contract unit price per hour, which payment shall be full compensation for applying the asphalt binder coat.

SECTION 413 ASPHALTIC CONCRETE (ASPHALT-RUBBER):

413-1 Description:

Asphaltic Concrete (Asphalt-Rubber), hereinafter asphaltic concrete, shall consist of furnishing all materials, mixing at a plant, hauling, and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt-rubber) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications, and as directed by the Engineer.

The contractor shall be responsible for all adjustments to its equipment necessary to properly accommodate the use of asphalt-rubber as a bituminous material.

413-2 Asphaltic Concrete Mix Design Criteria:

Mix designs will be performed in accordance with Arizona Test Method 815, modified as necessary for Asphaltic Concrete (Asphalt-Rubber). Mix designs shall meet the criteria in Table 413-1.

TABLE 413-1 ASPHALTIC CONCRETE MIX DESIGN CRITERIA	
Criteria	Requirement
1. Effective Voids: %, Range	5.5 ± 1.0
2. Voids in Mineral Aggregate: %, Min.	19.0
3. Absorbed Asphalt-Rubber: %, Range	0 - 1.0

413-3 Materials:

413-3.01 Mineral Aggregate Source:

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source in accordance with the requirements of Section 1001 of these specifications.

When the contractor selects a source or sources, it shall notify the Engineer. The contractor shall be solely responsible for assuring that the mineral aggregate meets all requirements and, when processed, is fully capable of providing asphaltic concrete which meets all the requirements of these specifications.

413-3.02 Mineral Aggregate:

Coarse and intermediate mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing a No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as mineral aggregate, so all crushing operations are inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the mineral aggregate has been crushed. Any material inspected by the Department as crushed material shall be separated from the contractors other stockpiles and reserved for use by the Department.

Mineral aggregate shall be separated into stockpiles by the contractor. No individual stockpile usage shall be less than three percent of the total mineral aggregate. No individual stockpile shall be permitted to contain more than 6.0 percent passing the No. 200 sieve when tested in accordance with Arizona Test Method 201. If necessary, the contractor shall wash the mineral aggregate to meet this requirement.

Mineral aggregate furnished for mix designs shall be representative of the source(s), and sampled from the materials stockpiles to be utilized in asphaltic concrete production. Mix designs shall be performed utilizing mineral aggregate which conforms to the grading limits in Table 413-2.

TABLE 413-2 MIX DESIGN GRADING LIMITS FOR MINERAL AGGREGATE (WITHOUT ADMIXTURE)	
Sieve Size	Percent Passing
3/4 Inch	100
1/2 Inch	80 - 100
3/8 Inch	65 - 80
No. 4	28 - 42
No. 8	14 - 22
No. 200	0 - 2.5

Mineral aggregate shall conform to the requirements in Table 413-3 when tested in accordance with the applicable test methods.

Tests on aggregates outlined in Table 413-3, other than abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on samples from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

TABLE 413-3 MINERAL AGGREGATE CHARACTERISTICS		
Characteristics	Test Method	Requirement

TABLE 413-3 MINERAL AGGREGATE CHARACTERISTICS		
Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	Arizona Test Method 815	2.35 - 2.85
Combined Water Absorption	Arizona Test Method 815	0 - 2.5%
Sand Equivalent	AASHTO T 176	Minimum 55
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 85% (two Fractured Faces determined on plus No. 4 material)
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%

413-3.03 Mineral Admixture:

Mineral admixture will be required. The amount shall be 1.0 percent, by weight of the mineral aggregate, and shall be either Portland Cement type II or hydrated lime, conforming to the requirements of Table 413-4.

TABLE 413-4 MINERAL ADMIXTURE	
Material	Requirement
Portland Cement, Type II	ASTM C 150
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

413-3.04 Bituminous Material:

Bituminous material shall be asphalt-rubber conforming to the requirements of Section 1009 of the specifications. The type of asphalt-rubber shall be as shown in the Special Provisions. The crumb rubber gradation shall be Type B conforming to the requirements of Section 1009.

In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated shall be rejected.

Any kerosene or other solvents used in the cleaning of equipment shall be purged from the system prior to any subsequent use of that equipment.

413-3.05 Blotter Material:

An application of blotter material may be required following the placement of the asphaltic concrete and prior to opening the roadway to traffic. The blotter material shall conform to the requirements of Section 404. The blotter material shall be applied in one or more applications for a total application of two pounds per square yard. The Engineer may reduce or eliminate blotter material if deemed to be unnecessary.

413-4 Mix Design:

Approximately 300 pounds of produced mineral aggregate, in proportion to the anticipated percent usage, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregate to be utilized in the asphaltic concrete production.

The contractor shall also furnish representative samples of the following materials: a five-pound sample of the crumb rubber proposed for use, one gallon of asphalt cement from the intended supplier, three gallons of the proposed mixture of asphalt and rubber, and a one-gallon can of the mineral admixture to be used in the asphaltic concrete.

Along with the samples furnished for mix design testing, the contractor shall submit a letter explaining in detail its methods of producing mineral aggregate including wasting, washing, blending, proportioning, etc., and any special or limiting conditions it may propose. The contractor's letter shall also state the source(s) of mineral aggregate, the source of asphalt cement and crumb rubber, the asphalt-rubber supplier, and the source and type of mineral admixture.

Within 10 working days of receipt of all samples and the contractor's letter in the Central Laboratory, the Department will provide the contractor with the percentage of asphalt-rubber to be used in the mix, the percentage to be used from each of the stockpiles of mineral aggregate, the composite mineral aggregate gradation, the composite mineral aggregate and mineral admixture gradation, and any special or limiting conditions for the use of the mix.

The Department will provide the contractor with material to be used for calibration of nuclear asphalt content gauges. The material will be fabricated by the Department utilizing asphalt-rubber submitted by the contractor for mix design purposes.

413-5 Mix Design Revisions:

The contractor shall not change its methods of crushing, screening, washing or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer, or without requesting a new mix design.

During production of asphaltic concrete, the contractor, on the basis of field test results, may request a change to the approved mix design. The Engineer will evaluate the proposed changes and notify the contractor of the Engineer's decision within two working days of the receipt of the request.

If, at any time, unapproved changes are made in the source of bituminous material, source(s) of mineral aggregate, production procedures, or proportional changes in violation of approved mix design stipulations, production shall cease until a new mix design is developed, or the contractor complies with the approved mix design.

At any time after the mix design has been approved, the contractor may request a new mix design.

The costs associated with the testing of materials in the developing of mix designs after a mix design acceptable to the Department has been developed shall be borne by the contractor.

If, during production, the Engineer on the basis of testing determines that a change in the mix design is necessary, the Engineer will issue a revised mix design. Should these changes require revisions to the contractor's operations which result in additional cost to the contractor, the contractor will be reimbursed for these costs. However, the Engineer reserves the right to modify the asphalt-rubber content without compensation being made to the contractor involving additional operation costs.

413-6 Acceptance of Materials:

413-6.01 General:

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified hereinafter under Subsection 413-6.03, or because changes are made in the mix design, samples will be taken for calculating new consecutive averages either after production resumes or after the changes in the mix design have been made. The acceptance of the mineral aggregate gradation and the bituminous material content will be determined on the basis of the tests as hereinafter specified under Subsection 413-6.03. The Engineer reserves the right to increase the frequency of sampling and testing upon the resumption of asphaltic concrete production.

413-6.02 Mineral Aggregate:

Aggregate shall be free of deleterious materials, clay balls, and adhering films or other materials that prevent thorough coating of the aggregate with the bituminous material.

During asphaltic concrete production, the Engineer shall obtain and test samples of mineral aggregate for the determination of the sand equivalent and fractured coarse aggregate particles. The sample shall be obtained either from the cold feed prior to addition of mineral admixture, or from the stockpiles. Should such testing indicate results not meeting the requirements outlined in table 413-3 for sand equivalent and fractured coarse aggregate particles, operations shall cease and the contractor shall have the option of requesting a new mix design or correcting deficiencies in the aggregate stockpiles.

413-6.03 Asphaltic Concrete:

(A) Mineral Aggregate Gradation:

For each approximate 500 tons of asphaltic concrete, at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of Arizona Test Method 105 on a random basis just prior to the addition of mineral admixture and bituminous material by means of a sampling device which is capable of producing samples which are representative of the mineral aggregate. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance with the mix design gradation without mineral admixture in accordance with the requirements of Arizona Test Method 201.

The gradation of the mineral aggregate will be considered to be acceptable unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests	
	3 Consecutive	One
3/8 Inch and larger	± 4	± 6
No. 4	± 4	± 6
No. 8	± 3	± 5
No. 200	± 1.0	± 1.5

One hundred percent of the material shall pass the largest sieve size shown in Table 413-2.

At any time that test results indicate that the gradation of the mineral aggregate does not fall within all of the limits indicated, the production of asphaltic concrete shall cease immediately and shall not begin again until a calibration test indicates that the gradation is within the 3-consecutive test limits indicated.

(B) Asphalt-Rubber Content:

During production of asphaltic concrete, the contractor shall maintain at the plant site a nuclear asphalt content gauge calibrated and operated in accordance with Arizona Test Method 421. The calibration shall be performed using material supplied by the Department as stated in Section 413-4. Under the observation of the Engineer, the contractor shall determine the asphalt-rubber content by means of the nuclear asphalt content gauge a minimum of four times per full shift. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in the Department's System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009-3740. Production of asphaltic concrete shall cease immediately and the plant and/or the nuclear asphalt content gauges re-calibrated if the Engineer determines the percent of asphalt-rubber has varied by an amount greater than ± 0.5 percent from the amount directed by the Engineer.

413-7 Construction Requirements:

413-7.01 Quality Control:

Quality control of mineral aggregate production and asphaltic concrete production shall be the responsibility of the contractor. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for the Engineer's own use.

413-7.02 Stockpiling:

The contractor will not be allowed to feed the hot plant from stockpiles containing less than two full days of production unless only two days production remain to be done or special conditions exist where the Engineer deems this requirement waived.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

413-7.03 Proportioning:

The contractor shall provide documentation by calibration charts or other approved means that the mineral aggregate, asphalt-rubber, and mineral admixture are being proportioned in accordance with the approved mix design.

Unless approved by the Engineer, no individual stockpile usage shall be less than three percent of the total mineral aggregate.

Changes in stockpile/hot bin use in excess of five percent from the approved mix design will not be permitted without the approval of the Engineer.

Mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt-rubber. The engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of the aggregate and admixture.

If a drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The mineral admixture shall be weighed across a weigh belt or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the mixture of aggregate and admixture to fall through mixing blades onto a belt or chute are not acceptable. The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of material feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum.

The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates.

A positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum drier, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt-rubber.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If the Engineer so determines, the Engineer will authorize in writing the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are uniformly metered into the mixture.

Mineral aggregate, mineral admixture, and asphalt-rubber shall be proportioned by volume, by weight, or by a combination of volume and weight.

When mineral aggregate, mineral admixture, and asphalt-rubber are proportioned by weight, all boxes, hoppers, buckets, or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the rest of the plant due to the operation of any equipment so that the error in weighing with the entire plant operating shall not exceed two percent for any setting nor one and one half percent for any batch. Bituminous material shall be weighed in a heated, insulated bucket suspended from a springless dial scale system.

When mineral aggregate, mineral admixture, and asphalt-rubber are proportioned by volume, the correct portion of each mineral aggregate size introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder which will supply the correct amount of mineral aggregate in proportion to the bituminous material and so arranged that the proportion of each mineral aggregate size can be separately adjusted. The continuous feeder for the mineral aggregate shall be mechanically or electrically actuated.

The introduction of asphalt-rubber shall be controlled by an automated system fully integrated with the controls for mineral aggregate and mineral admixture.

413-7.04 Drying and Heating:

A recording pyrometer or other approved recording thermometric instrument sensitive to a rate of temperature change not less than 10 degrees F per minute shall be so placed at the discharge chute of the drier in order to record automatically the temperature of the asphaltic

concrete or mineral aggregate. A copy of the recording shall be given to the Engineer at the end of each shift.

The moisture content of the asphaltic concrete shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

413-7.05 Mixing:

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials.

A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 350 degrees F. If the asphaltic concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphaltic concrete will be minimized.

413-7.06 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with asphalt cement in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.

A light coat of asphalt cement shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.

The base or subgrade upon which the asphaltic concrete is to be placed shall be prepared in accordance with the applicable requirement for the material involved and maintained in a smooth and firm condition until placement. Asphaltic concrete shall not be placed on a frozen or excessively wet base or subgrade.

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F and the ambient temperature is at least 65 degrees F and rising. The placement shall be stopped when the ambient temperature is at or below 70 degrees F and falling.

At any time the Engineer may require that the work cease or that the work day be reduced in the event of weather conditions which would have an adverse effect upon the asphaltic concrete.

All asphaltic concrete shall be placed either as a leveling course or as a surfacing course. Leveling courses are defined as courses placed for the primary purpose of raising an existing paved or unpaved surface to a smooth plane. Surfacing courses are defined as courses placed to serve either as the traffic surface or as a surface upon which a finishing course or seal coat is to be placed.

Thickness of leveling and surfacing courses will be shown on the project plans. No change in thickness will be allowed without the written approval of the Engineer.

(B) Loading Asphaltic Concrete into the Paving Machine:

If the asphaltic concrete is dumped directly into the paving machine from the hauling trucks, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, the loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing Asphaltic Concrete by Means of Self-Propelled Paving Machines:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

In order to achieve, as far as practical, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant. If the paving machine is stopped for more than three minutes, or there is a three minute or longer interval between the completion of delivery by one truck and the beginning of delivery by the next truck, the paving machine shall be pulled away from the mat in order for the rollers to compact this area in accordance with the temperature limitations given hereinafter under Subsection 413-7.08(C). A transverse construction joint shall be made by a method approved by the Engineer.

Self-propelled paving machines shall spread the mixture without segregation or tearing within the specified tolerances, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving or gouging the mixture and which produces a course with

a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding eight feet in width, or widened sections not exceeding four feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impractical, all courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternately when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

Ski-type device at least 30 feet in length, supported throughout its entire length.

Short ski.

500 feet of control line and stakes.

Joint matcher shoe.

The control line shall be set and maintained taut by the contractor to the grade and alignment established by the Engineer.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

413-7.07 Joints:

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of the immediate underlying course.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot lapped, and shall be compacted while the mixture is still hot.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

When surfacing courses are placed on ten-foot or wider shoulders that are to receive a rumble strip, any longitudinal joint between the shoulder and the travel lane shall be located at the travel lane edge of the rumble strip.

413-7.08 Compaction:

(A) General Requirements:

The temperature of asphaltic concrete just prior to compaction shall be at least 275 °F.

The wheels of compactors shall be wetted with water, or if necessary soapy water, or a product approved by the Engineer to prevent the asphaltic concrete from sticking to the steel wheels during rolling. The Engineer may change the rolling procedure if in the Engineer's judgment the change is necessary to prevent picking up of the asphaltic concrete.

(B) Equipment:

For courses greater than one inch in nominal thickness, a minimum of one static steel-wheel compactor and two vibratory steel-wheel compactors shall be provided; however, sufficient vibratory steel-wheel compactors shall be provided to cover the entire width of the paving machine on the initial forward pass.

For courses of one inch or less in nominal thickness, a minimum of three static steel-wheel compactors shall be provided; however, sufficient compactors must be provided to cover the entire width of the paving machine on the initial forward pass while a static compactor remains to complete final rolling. If the asphaltic concrete production rate exceeds 250 tons per hour, an additional static steel-wheel compactor shall be provided.

The compactors shall weigh not less than eight tons.

The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. Vibratory rollers shall be used in the mode required by the Engineer. Vibratory compactors shall not be used in the vibratory mode for courses of one inch or less in nominal thickness.

(C) Rolling Procedure:

Vibratory compactors shall be used for initial breakdown on courses greater than one inch in nominal thickness. Static steel wheel compactors, or vibratory compactors in the static mode, shall be used for initial breakdown on courses one inch or less in nominal thickness. Initial breakdown rollers shall be maintained no more than 300 feet behind the paving machine. The roller(s) for final compaction shall follow as closely behind the initial breakdown as possible. As many passes as are possible shall be made with the compactors before the temperature of the asphaltic concrete falls below 220 °F.

All edges shall be compacted by methods approved by the Engineer, while the mixture is still hot.

413-7.09 Surface Requirements and Tolerances:

All courses of asphaltic concrete shall be compacted as required, smooth and reasonably true to the required lines, grades, and dimensions.

Leveling course surfaces shall not vary more than 1/4 inch from the lower edge of a 10-foot straightedge when the straightedge is placed parallel to the center line of the roadway.

Surfacing course surfaces shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway, or 1/4 inch when placed in the transverse direction across longitudinal joints.

413-7.10 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

413-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, mineral admixture, and asphalt-rubber. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt-rubber material will be measured by the ton.

The weight of the asphalt-rubber material shall either be determined by weighing directly enroute from the reaction vessel to the point of delivery or be determined from the weight of the asphalt cement and the weight of the rubber minus wastage.

Mineral admixture will be measured by the ton.

413-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton, which price shall be full compensation for the work, complete in place, as specified herein.

Payment for the asphalt-rubber will be made by the ton, including asphalt cement and crumb rubber. The results of a nuclear asphalt content gauge shall not be used to determine the weight of asphalt-rubber material as the basis of payment.

Payment for mineral admixture will be made by the ton.

SECTION 414 ASPHALTIC CONCRETE FRICTION COURSE (ASPHALT-RUBBER):

414-1 Description:

Asphaltic Concrete Friction Course (Asphalt-Rubber), hereinafter asphaltic concrete, shall consist of furnishing all materials, mixing at a plant, hauling, and placing a mixture of aggregate materials, mineral admixture, and bituminous material (asphalt-rubber) to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications, and as directed by the Engineer.

The contractor shall be responsible for all adjustments to its equipment necessary to properly accommodate the use of asphalt-rubber as a bituminous material.

414-2 Asphaltic Concrete Mix Design Criteria:

Mix designs will be performed in accordance with Arizona Test Method 814, modified as necessary for Asphaltic Concrete Friction Course (Asphalt-Rubber). The allowable range of percent absorbed asphalt-rubber shall be 0-1.0, when tested in accordance with the applicable section of Arizona Test Method 815.

414-3 Materials:

414-3.01 Mineral Aggregate Source:

There is no Department-furnished source of mineral aggregate. The contractor shall provide a source in accordance with the requirements of Section 1001 of these specifications.

When the contractor selects a source or sources, it shall notify the Engineer. The contractor shall be solely responsible for assuring that the mineral aggregate meets all requirements and, when processed, is fully capable of providing asphaltic concrete which meets all the requirements of these specifications.

414-3.02 Mineral Aggregate:

Mineral aggregate shall be separated into at least two stockpiles. No individual stockpile usage shall be less than three percent of the total mineral aggregate.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert materials with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate or blend material shall consist of natural sand, sand prepared from rock, or other approved inert materials, or a combination thereof, conforming to the requirements of these specifications.

Material aggregate furnished for mix designs shall be representative of the source(s) and sampled from the materials stockpiles to be utilized in asphaltic concrete production. Mix designs shall be performed utilizing mineral aggregate which conforms to the grading limits in Table 414-1.

TABLE 414-1 MIX DESIGN GRADING LIMITS FOR MINERAL AGGREGATE (Without Admixture)	
Sieve Size	Percent Passing
3/4 Inch	100
No. 4	30 - 45
No. 8	4 - 8
No. 200	0 - 2.5

Mineral aggregate shall conform to the requirements in Table 414-2 when tested in accordance with the applicable test methods.

Tests on aggregates outlined in Table 414-2, other than abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on samples from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

TABLE 414-2 MINERAL AGGREGATE CHARACTERISTICS		
Characteristic	Test Method	Requirement
Combined Bulk Specific Gravity	Arizona Test Method 814	2.35 - 2.85
Combined Water Absorption	Arizona Test Method 814	0 – 2.5%
Sand Equivalent	Arizona Test Method 242	Minimum 55
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 85% (two fractured faces)
Flakiness Index	Arizona Test Method 233	Maximum 25

TABLE 414-2 MINERAL AGGREGATE CHARACTERISTICS		
Characteristic	Test Method	Requirement
Carbonates in Aggregate	Arizona Test Method 238	Maximum 30%
Abrasion	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%

414-3.03 Mineral Admixture:

Mineral admixture will be required. The amount shall be 1.0 percent, by weight of the mineral aggregate and shall be either portland cement type II or hydrated lime, conforming to the requirements of Table 414-3.

TABLE 414-3 MINERAL ADMIXTURE	
Material	Requirement
Portland Cement, Type II	ASTM C 150
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

414-3.04 Bituminous Material:

Bituminous material shall be asphalt-rubber conforming to the requirements of Section 1009 of the specifications. The type of asphalt-rubber shall be as shown in the Special Provisions. The crumb rubber gradation shall be Type B conforming to the requirements of Section 1009.

In no case shall the asphalt-rubber be diluted with extender oil, kerosene, or other solvents. Any asphalt-rubber so contaminated shall be rejected.

Any kerosene or other solvents used in the cleaning of equipment shall be purged from the system prior to any subsequent use of that equipment.

414-4 Mix Design:

Approximately 300 pounds of produced mineral aggregate, in proportion to the anticipated percent usage, shall be obtained by the contractor and witnessed by the Engineer so that both parties are satisfied that samples are representative of the mineral aggregate to be utilized in the asphaltic concrete production.

The contractor shall also furnish representative samples of the following materials: a five-pound sample of the crumb rubber proposed for use, one gallon of asphalt cement from the intended supplier, three gallons of the proposed mixture of asphalt and rubber, and a one-gallon can of the mineral admixture to be used in the asphaltic concrete.

Along with the samples furnished for mix design testing, the contractor shall submit a letter explaining in detail its methods of producing mineral aggregate including wasting, washing, blending, proportioning, etc., and any special or limiting conditions it may propose. The contractor's letter shall also state the source(s) of mineral aggregate, the source of asphalt cement and crumb rubber, the asphalt-rubber supplier, and the source and type of mineral admixture.

Within 10 working days of receipt of all samples and the contractor's letter in the Central Laboratory, the Department will provide the contractor with the percentage of asphalt-rubber to be used in the mix, the percentage to be used from each of the stockpiles of mineral aggregate, the composite mineral aggregate gradation, the composite mineral aggregate and mineral admixture gradation, and any special or limiting conditions for the use of the mix.

The Department will provide the contractor material to be used for calibration of nuclear asphalt content gauges. The material will be fabricated by the Department utilizing asphalt-rubber submitted by the contractor for mix design purposes.

414-5 Mix Design Revisions:

The contractor shall not change its methods of crushing, screening, washing, or stockpiling from those used during production of material used for mix design purposes without approval of the Engineer, or without requesting a new mix design.

During production of asphaltic concrete, the contractor, on the basis of field test results, may request a change to the approved mix design. The Engineer will evaluate the proposed changes and notify the contractor of the Engineer's decision within two working days of the receipt of the request.

If, at any time, unapproved changes are made in the source of bituminous material, source(s) of mineral aggregate, production methods, or proportional changes in violation of approved mix design stipulations, production shall cease until a new mix design is developed, or the contractor complies with the approved mix design.

At any time after the mix design has been approved, the contractor may request a new mix design.

The costs associated with the testing of materials in the developing of mix designs after a mix design acceptable to the Department has been developed shall be borne by the contractor.

If, during production, the Engineer on the basis of testing determines that a change in the mix design is necessary, the Engineer will issue a revised mix design. Should these changes require revisions to the contractor's operations which result in additional cost to the contractor, it will be reimbursed for these costs. However, the Engineer reserves the right to modify the asphalt-rubber content without compensation being made to the contractor involving additional operation costs.

414-6 Acceptance of Materials:

414-6.01 General:

If the production of asphaltic concrete is stopped either for failure to meet the requirements specified hereinafter under Subsection 414-6.03, or because changes are made in the mix design, samples will be taken for calculating new consecutive averages either after production resumes or after the changes in the mix design have been made. The acceptance of the mineral aggregate gradation and the bituminous material content will be determined on the basis of the tests as hereinafter specified under Subsection 414-6.03. The Engineer reserves the right to increase the frequency of sampling and testing upon the resumption of asphaltic concrete production.

414-6.02 Mineral Aggregate:

Aggregate shall be free of deleterious materials, clay balls, and adhering films or other material that prevent thorough coating of the aggregate with the bituminous material.

During asphaltic concrete production, the Engineer shall obtain and test samples of mineral aggregate for the determination of the sand equivalent, fractured coarse aggregate particles, and flakiness index. The sample shall be obtained either from the cold feed prior to addition of mineral admixture, or from the stockpiles. Should such testing indicate results not meeting the requirements of Table 414-2 for sand equivalent, fractured coarse aggregate particles, and flakiness index, operations shall cease and the contractor shall have the option of requesting a new mix design or correcting deficiencies in the aggregate stockpiles.

414-6.03 Asphaltic Concrete:

(A) Mineral Aggregate Gradation:

For each approximate 500 tons of asphaltic concrete, at least one sample of mineral aggregate will be taken. Samples will be taken in accordance with the requirements of Arizona Test Method 105 on a random basis just prior to the addition of mineral admixture and bituminous material by means of a sampling device which is capable of producing samples which are representative of the mineral aggregate. The device, which shall be approved by the Engineer, shall be furnished by the contractor. In any shift that the production of asphaltic concrete is less than 500 tons, at least one sample will be taken.

Samples will be tested for conformance with the mix design gradation without mineral admixture in accordance with the requirements of Arizona Test Method 201.

The gradation of the mineral aggregate will be considered to be acceptable, unless the average of any three consecutive tests or the result of any single test varies from the mix design gradation percentages as follows:

Passing Sieve	Number of Tests
---------------	-----------------

	3 Consecutive	One
No. 4	± 4	± 6
No. 8	± 3	± 4
No. 200	± 1.0	± 1.5

One hundred percent of the material shall pass the largest sieve size shown in Table 414-1.

At any time that test results indicate that the gradation of the mineral aggregate does not fall within all of the limits indicated, the production of asphaltic concrete shall cease immediately and shall not begin again until a calibration test indicates that the gradation is within the 3-consecutive test limits indicated.

(B) Asphalt-Rubber Content:

During production of asphaltic concrete, the contractor shall maintain at the plant site a nuclear asphalt content gauge calibrated and operated in accordance with Arizona Test Method 421. The calibration shall be performed using material supplied by the Department as stated in Section 414-4. Under the observation of the Engineer, the contractor shall determine the asphalt-rubber content by means of the nuclear asphalt content gauge a minimum of four times per full shift. The contractor's technicians performing the testing, including the calibration of the nuclear gauge, shall meet the technician requirements given in the Department's System for the Evaluation of Testing Laboratories. The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, AZ 85009. Production of asphaltic concrete shall cease immediately and the plant and/or the nuclear asphalt content gauges re-calibrated if the Engineer determines the percent of asphalt-rubber has varied by an amount greater than ± 0.5 percent from the amount directed by the Engineer.

414-7 Construction Requirements:

414-7.01 Quality Control:

Quality control of mineral aggregate production and asphaltic concrete production shall be the responsibility of the contractor. The contractor shall perform sufficient testing to assure that mineral aggregate and asphaltic concrete are produced which meet all specified requirements. The Engineer reserves the right to obtain samples of any portion of any material at any point of the operations for the Engineer's own use.

414-7.02 Stockpiling:

The contractor will not be allowed to feed the hot plant from stockpiles containing less than two full days of production unless only two days production remain to be done or special conditions exist where the Engineer deems this requirement waived.

Mineral aggregate shall be separated and stockpiled so that segregation is minimized. An approved divider of sufficient size to prevent intermingling of stockpiles shall be provided.

414-7.03 Proportioning:

The contractor shall provide documentation by calibration charts or other approved means that the mineral aggregate, asphalt-rubber, and mineral admixture are being proportioned in accordance with the approved mix design.

Unless approved by the Engineer, no individual stockpile usage shall be less than three percent of the total mineral aggregate.

Changes in stockpile/hot bin use in excess of five percent from the approved mix design will not be permitted without the approval of the Engineer.

Mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt-rubber. The engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of the aggregate and admixture.

If a drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The mineral admixture shall be weighed across a weigh belt or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the mixture of aggregate and admixture to fall through mixing blades onto a belt or chute are not acceptable. The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of material feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates.

A positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum drier, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt-rubber.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

No fine material which has been collected in the dust collection system shall be returned to the mixture unless the Engineer, on the basis of tests, determines that all or a portion of the collected fines can be utilized. If the Engineer so determines, the Engineer will authorize in writing the utilization of a specific proportion of the fines; however, authorization will not be granted unless the collected fines are uniformly metered into the mixture.

Mineral aggregate, mineral admixture, and asphalt-rubber shall be proportioned by volume, by weight, or by a combination of volume and weight.

When mineral aggregate, mineral admixture, and asphalt-rubber are proportioned by weight, all boxes, hoppers, buckets, or similar receptacles used for weighing materials, together with scales of any kind used in batching materials, shall be insulated against the vibration or movement of the rest of the plant due to the operation of any equipment so that the error in weighing with the entire plant operating shall not exceed two percent for any setting nor 1-1/2 percent for any batch. Bituminous material shall be weighed in a heated, insulated bucket suspended from a springless dial scale system.

When mineral aggregate, mineral admixture, and asphalt-rubber are proportioned by volume, the correct portion of each mineral aggregate size introduced into the mixture shall be drawn from the storage bins by an approved type of continuous feeder which will supply the correct amount of mineral aggregate in proportion to the bituminous material and so arranged that the proportion of each mineral aggregate size can be separately adjusted. The continuous feeder for the mineral aggregate shall be mechanically or electrically actuated.

The introduction of asphalt-rubber shall be controlled by an automated system fully integrated with the controls for mineral aggregate and mineral admixture.

414-7.04 Drying and Heating:

A recording pyrometer or other approved recording thermometric instrument sensitive to a rate of temperature change not less than 10 degrees F per minute shall be so placed at the discharge chute of the drier in order to record automatically the temperature of the asphaltic concrete or mineral aggregate. A copy of the recording shall be given to the Engineer at the end of each shift.

The moisture content of the asphaltic concrete shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

414-7.05 Mixing:

The production of the plant shall be governed by the rate required to obtain a thorough and uniform mixture of the materials.

A positive signal system shall be provided to indicate the low level of mineral aggregate in the bins. The plant will not be permitted to operate unless this signal system is in good working condition. Each bin shall have an overflow chute or a divider to prevent material from spilling into adjacent bins.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 350 degrees F. If the asphaltic concrete is discharged from the mixer into a hopper, the hopper shall be constructed so that segregation of the asphaltic concrete will be minimized.

414-7.06 Placing and Finishing:

(A) General Requirements:

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of all objectionable material and tacked with asphalt cement in accordance with the requirements of Section 404 of the specifications. The cleaning of the surface, the tacking of the surface, and the amount and grade of asphalt cement used shall be as directed by and acceptable to the Engineer.

Unless otherwise specified on the project plans, asphaltic concrete shall not be placed on the two-foot widened section where guardrail is to be installed.

(1) Dates and Surface Temperature:

Asphaltic concrete shall be placed between the dates specified in the Special Provisions and only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 85 °F.

Despite a surface temperature of 85 °F, the Engineer at any time may require that the work cease or that the work day be reduced in the event of weather conditions either existing or expected which would have an adverse effect upon the asphaltic concrete.

(2) Delivery to Screed Unit:

Asphaltic concrete delivered to the screed unit shall be a free flowing, homogeneous mass in which there is no segregation, crusts, lumps, or migration of the asphalt-rubber.

Should any one or more of such conditions be evident in the material delivered to the screed unit, and which cannot be eliminated by one or more of the following methods, the Engineer will order the work to be stopped until conditions are conducive to the delivery of the material in the condition as hereinbefore required:

- (a) Covering hauling units with tarpaulins.
- (b) Dumping material directly into the paver.
- (c) Moving the hot plant nearer to the point of delivery.

Other measures proposed by the contractor which will deliver asphaltic concrete meeting the above requirements will be considered by the Engineer.

(B) Loading Asphaltic Concrete into the Paving Machine:

If the asphaltic concrete is dumped directly into the paving machine from the hauling trucks, care shall be taken to avoid jarring the machine or moving it out of alignment. No vertical load shall be exerted on the paving machine by the trucks. Trucks, while dumping, shall be securely attached to the paving machine.

If the asphaltic concrete is dumped upon the surface being paved and subsequently loaded into the paving machine, it shall not be dumped at a distance greater than 150 feet in front of the paving machine. The loading equipment shall be self-supporting and shall not exert any vertical load on the paving machine. Substantially all of the asphaltic concrete shall be picked up and loaded into the paving machine.

(C) Placing and Finishing Asphaltic Concrete by Means of Self-Propelled Paving Machines:

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

In order to achieve, as far as practical, a continuous operation, the speed of the paving machine shall be coordinated with the production of the plant. If the paving machine is stopped for more than three minutes, or there is a three-minute or longer interval between the completion of delivery by one truck and the beginning of delivery by the next truck, the paving machine shall be pulled away from the mat in order for the rollers to compact this area in accordance with the temperature limitations given hereinafter under Subsection 414-7.08(C). A transverse construction joint shall be made by a method approved by the Engineer.

Self-propelled paving machines shall spread the mixture without segregation or tearing within the specified tolerances, true to the line, grade, and crown indicated on the project plans. Pavers shall be equipped with hoppers and augers which will distribute the mixture uniformly in front of adjustable screeds.

Screeds shall include any strike-off device operated by tamping or vibrating action which is effective without tearing, shoving or gouging the mixture and which produces a course with a uniform texture and density for the full width being paved. Screeds shall be adjustable as to height and crown and shall be equipped with a controlled heating device for use when required.

Tapered sections not exceeding eight feet in width, or widened sections not exceeding four feet in width may be placed and finished by other means approved by the Engineer.

(D) Automatically Actuated Control System:

Except under certain conditions or at certain locations where the Engineer deems the use of automatic controls impractical, all courses of asphaltic concrete shall be placed and finished

by means of self-propelled paving machines equipped with an automatically actuated control system.

The control system shall control the elevation of the screed at each end by controlling the elevation of one end directly and the other end indirectly either through controlling the transverse slope or alternately when directed, by controlling the elevation of each end independently.

The control system shall be capable of working with the following devices which shall be furnished with the machine:

Ski-type device at least 30 feet in length, supported throughout its entire length.

Short ski.

Failure of the control system to function properly shall be cause for the suspension of the asphaltic concrete operations.

414-7.07 Joints:

If the lift thickness is equal to or greater than one inch, the contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

Longitudinal joints shall be located within one foot of the centerline between two adjacent lanes.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

414-7.08 Compaction:

(A) General Requirements:

The temperature of asphaltic concrete just prior to compaction shall be at least 275 degrees F.

The wheels of compactors shall be wetted with water, or if necessary soapy water, or a product approved by the Engineer to prevent the asphaltic concrete from sticking to the steel wheels during rolling. The Engineer may change the rolling procedure if in the

Engineer's judgment the change is necessary to prevent picking up of the asphaltic concrete.

(B) Equipment:

A minimum of three static steel wheel compactors shall be provided. The drums shall be of sufficient width that when staggered, two compactors can cover the entire width of the ribbon with one pass.

The compactors shall weigh not less than eight tons.

The compactors shall be self-propelled and shall be operated with the drive wheel in the forward position. Vibrator rollers may be used in the static mode only.

(C) Rolling Procedure:

Two compactors shall be used for initial breakdown and be maintained no more than 300 feet behind the paving machine. The roller(s) for final compaction shall follow as closely behind the initial breakdown as possible. As many passes as is possible shall be made with the compactors before the temperature of the asphaltic concrete falls below 220 °F

414-7.09 Surface Requirements and Tolerances:

Asphaltic concrete shall be compacted as required, smooth and reasonably true to the required lines, grades, and dimensions.

Asphaltic concrete shall not vary more than 1/8 inch from the lower edge of a ten-foot straightedge when the straightedge is placed parallel to the center line of the roadway, or 1/4 inch when placed in the transverse direction across longitudinal joints.

414-7.10 Acceptance:

Asphaltic concrete will be accepted complete in place, if, in the judgment of the Engineer, the asphaltic concrete reasonably conforms to the requirements specified herein. Asphaltic concrete that is not acceptable and is rejected shall be replaced to the satisfaction of the Engineer and at no expense to the Department.

414-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the mixture actually used, which will include the weight of mineral aggregate, mineral admixture and asphalt-rubber. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt-rubber will be measured by the ton.

The weight of the asphalt-rubber material shall either be determined by weighing directly enroute from the reaction vessel to the point of delivery or be determined from the weight of the asphalt cement and the weight of the rubber minus wastage.

Mineral admixture will be measured by the ton.

414-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price per ton, which price shall be full compensation for the work, complete in place, as specified herein.

Payment for the asphalt-rubber will be made by the ton, including asphalt cement and crumb rubber. The results of a nuclear asphalt content gauge shall not be used to determine the weight of asphalt-rubber material as the basis of payment.

Payment for mineral admixture will be made by the ton.

SECTION 415 BLANK

SECTION 416 ASPHALTIC CONCRETE - END PRODUCT:

416-1 Description:

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture if required, and an asphalt cement to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

It is the intent of this specification that the contractor acquire and make all arrangements for a source or sources of material; that it furnish Certificates of Compliance as hereinafter specified; that it furnish a mix design which will meet the design criteria specified hereinafter; and that it provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

416-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor on the basis of the following criteria and tested in accordance with the requirements of the following test methods:

Criteria	Requirements			Arizona Test Method
	1/2" Mix	3/4" Mix	Base Mix	
1. Voids in Mineral Aggregate: %, Range	15.5 - 18.5	15.0 - 18.0	14.5 - 17.0	815
2. Effective Voids: %, Range	Note (1)	Note (1)	Note (1)	815

3.	Absorbed Asphalt: %, Range	0 - 1.0	0 - 1.0	0 - 1.0	815	
4.	Index of Retained Strength: %, Minimum, Note (2)	60	60	60	802	
5.	Wet Strength: psi, Minimum	150	150	150	802	
6.	Stability: pounds, Minimum	2,000	2,000	3,000	815	
7.	Flow: 0.01-inch, Range	8 - 16	8 - 16	8 - 16	815	
8. Mineral Aggregate Grading Limits					201	
Sieve Size	Percent Passing					
	1/2 inch Mix		3/4 inch Mix		Base Mix	
	No Admix.	Includes Admix.	No Admix.	Includes Admix.	No Admix.	Includes Admix.
1-1/4 in.					100	100
1 inch			100	100	90 -100	90 - 100
3/4 inch	100	100	90 - 100	90 - 100	85 - 95	85 - 95
1/2 inch	90 - 100	90 - 100	---	---	---	---
3/8 inch	67 - 82	67 - 82	62 - 77	62 - 77	57 - 72	57 - 72
No. 8	40 - 48	41 - 49	37 - 46	38 - 47	32 - 42	33 - 43
No. 40	10 - 18	11 - 19	10 - 18	11 - 19	8 - 16	9 - 17
No. 200	1.5 - 4.5	2.5 - 6.0	1.5 - 4.5	2.5 - 6.0	1.5 - 3.5	2.0 - 5.0
(1) As specified in the Special Provisions						
(2) For interstate roadways, if the average elevation of the project is above 3500 feet, the index of retained strength shall be a minimum of 70 percent.						

The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be within the range specified in the Special Provisions.

416-3 Materials:

416-3.01 Mineral Aggregate:

The contractor shall provide a source of material in conformance with the requirements of Section 1001. Sub-paragraph (3) regarding sampling and testing under Subsection 1001-4(B) is hereby deleted.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

For areas or applications where Special Mix is not called for on the plans, fine mineral aggregate shall consist of natural sand or of sand prepared from rock, or other approved

inert materials, or a combination thereof, conforming to the requirements of these specifications.

For areas or applications where Special Mix is called for on the project plans, the following shall apply:

Fine mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the mineral aggregate has been crushed. Any material inspected by the Department as crushed material for the project shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

The contractor may blend uncrushed fine aggregate up to a maximum of 15 percent of the total aggregate, provided that the composite of uncrushed fine aggregate and crushed fine aggregate meets the requirement for uncompacted void content. The uncrushed fine aggregate shall be 100 percent passing the 1/4 inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods.

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	Arizona Test Methods 210 and 211	2.35 - 2.85
Combined Water Absorption	Arizona Test Methods 210 and 211	0 - 2.5%
Sand Equivalent	AASHTO T 176	Minimum 55
Abrasion	AASHTO T 96	100 Rev., Max. 9% 500 Rev., Max. 40%
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 70% (1)(at least one fractured face, determined on plus No. 4 material)

Mineral Aggregate Characteristics	Test Method	Requirement
Uncompacted Void Content (Special Mix Only)	Arizona Test Method 247	Minimum 45%
(1) When Special Mix is called for on the project plans, this value shall be Minimum 85% (two fractured faces), determined on plus No. 4 material.		

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on materials from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

Mineral aggregate from a source or combination of sources which does not meet the requirements, according to the contractor's mix design proposal, for combined bulk specific gravity and/or combined water absorption up to a maximum of 3.0 percent but meets other specified requirements will be further considered for acceptance by the Engineer if: a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement content and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

416-3.02 Mineral Admixture:

When the mix design includes a mineral admixture, the amount used shall be 1.0 percent, by weight, of the mineral aggregate unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for index of retained strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either Portland cement, blended hydraulic cement or hydrated lime conforming to the following requirements.

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 shall be submitted to the Engineer.

416-3.03 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. The type of asphalt binder shall be as shown in the Special Provisions.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the

un-aged asphalt binder has a rotational viscosity of 0.17 ± 0.02 pascal-seconds, measured in accordance with ASTM D 4402. The laboratory compaction temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity of 0.28 ± 0.03 pascal-seconds, measured in accordance with ASTM D 4402. The testing required in ASTM D 4402 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified by the asphalt binder supplier. The laboratory mixing and compaction temperature ranges shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report.

416-4 Mix Design:

Utilizing mineral aggregate which has been crushed, processed, separated and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate samples used for mix design purposes shall be representative of aggregate materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete.

The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing.

The mix design shall be prepared by a mix design laboratory that has met the requirements of the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009.

The use of a mix design developed for a previous project which meets these specifications may be proposed by the contractor provided the methods of producing mineral aggregate have not changed since the development of the mix design, the asphalt cement and mineral admixture type and source of supply have not changed, the mix design test values meet all current specification requirements, and the previous use of the mix design was satisfactory to the Department. The Engineer will determine whether a previously used mix design can be approved for use based upon the evidence provided by the contractor of current stockpile gradations, fractured coarse aggregate particles, and sand equivalent, and the evidence provided by the contractor that the results obtained during production under the previously used mix design were satisfactory. Should the Engineer question the evidence provided or determine the previous use was not satisfactory, the contractor shall prepare and submit a new mix design in accordance with these specifications.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.
- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) The supplier, refinery, type of asphalt cement and any modifiers including polymers, the source and type of mineral admixture, and the percentage of asphalt cement and mineral admixture to be used.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture if it is utilized.
- (6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, immersion compression results (Index of Retained Strength, wet and dry strengths), Marshall stability and flow, asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources.
- (7) Viscosity-Temperature curve along with the laboratory mixing and compaction temperature ranges.

The mix design shall be submitted in a format which clearly provides all the mix design requirements and be signed by a person authorized by the contractor to act in such matters on the contractor's behalf.

The mix design and representative samples of the mineral aggregate used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, for determination of the sand equivalent and fractured coarse aggregate particles, and for uncompacted void content when Special Mix is used, at least two working days prior to the start of asphaltic concrete production. Collection of the samples provided by the contractor shall be witnessed by the Engineer, and the samples shall be representative of the materials produced. For Special Mix, additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified. The sand equivalent will be determined in accordance with the requirements of AASHTO T 176, and the fractured coarse aggregate particles (for Special Mix, plus No. 4 material with at least two fractured faces) in accordance with Arizona Test Method 212. For Special Mix, the uncompacted void content shall be determined in accordance with Arizona Test Method 247. The sand equivalent determined by the Engineer must be at least 90 percent and not more than 110 percent of the value contained in the contractor's mix design, and meet the minimum requirements specified in Subsection 416-3.01. The fractured coarse aggregate particles and, for Special Mix the uncompacted void content, determined by the Engineer shall meet the minimum requirements specified in Subsection 416-3.01. If the mineral aggregate fails to meet these requirements, asphaltic concrete production shall not commence, and the contractor shall

either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information, for further action and resubmission by the contractor.

If the contractor elects to change its source of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. The self-directed target changes must meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size): 3/8 inch No. 8 No. 40 No. 200	$\pm 2\%$ from mix design target value $\pm 2\%$ from mix design target value $\pm 1\%$ from mix design target value None
Asphalt Cement Content	$\pm 0.2\%$ from mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

416-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in the Special Provisions.

416-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading and finishing of asphaltic concrete and for the applying of bituminous material, such as tack coats, prime coats and provisional seals, all in accordance with the appropriate portions of the specifications.

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 325 degrees F unless a higher temperature is recommended by the asphalt cement supplier and approved by the Engineer. A recording pyrometer or other approved thermometric instrument sensitive to a rate of temperature change of not less than 10 degrees F per minute shall be placed at the discharge chute of the drier so as to automatically record the temperature of the asphaltic concrete or mineral aggregate. A copy of the recording shall be delivered to the Engineer at the end of each shift of production.

If a mineral admixture is necessary to produce asphaltic concrete that meets the design criteria, the mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt cement. The Engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of aggregate and admixture.

If a conventional drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process. The mineral admixture shall be weighed across a weigh belt, or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the aggregate to fall through mixing blades onto a belt or chute are not acceptable. The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of aggregate feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates.

If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt cement. The system by which mineral admixture is incorporated into the production of asphaltic concrete at the pugmill shall be designed to minimize the loss of the mineral admixture.

The contractor's plant and equipment shall be capable of introducing admixture into the asphaltic concrete without significant loss of mineral admixture through the dust collection system of the plant. The method of introducing admixture into plant types other than a conventional drum mix or batch plant is subject to the approval of the Engineer.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

If a mineral admixture is used, a positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal

system shall be placed between the metering device and the drum dryer, and utilized during production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Pavers shall be equipped with an activated screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time the Engineer may require the work to cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be wiped when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on 10 foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After

placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

416-7 Acceptance:

416-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted void Content (for Special Mix)
- Material Spread
- Gradation
- Asphalt Cement Content
- Effective Voids
- Stability
- Compaction

Smoothness

416-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer will obtain and test samples of mineral aggregate for the determination of the sand equivalent and fractured coarse aggregate particles, and for determination of uncompacted void content when Special Mix is used. The sample shall be obtained either from the cold feed belt prior to the addition of mineral admixture, if used, or from the stockpiles. The sand equivalent will be determined by the Engineer in accordance with the requirements of AASHTO T 176, and the fractured coarse aggregate particles (for Special Mix, the plus No. 4 material with at least two fractured faces) will be determined in accordance with Arizona Test Method 212. For Special Mix, the uncompacted void content shall be determined in accordance with Arizona Test Method 247. Mineral aggregate will be acceptable for sand equivalent when the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design. Mineral aggregate shall meet the minimum requirements for fractured coarse aggregate particles and, for Special Mix, uncompacted void content specified in Subsection 416-3.01. For Special Mix, additional testing of the uncrushed and crushed fine aggregate for uncompacted void content will be required if the method of producing either fine aggregate is modified. If the mineral aggregate fails to meet these requirements, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 416-4 or correcting deficiencies in the aggregate stockpiles.

416-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D). Information pertaining to each lot shall be recorded by the contractor on forms provided by the Engineer.

Information recorded shall include the project number, date each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness and tons placed in each lot. The form shall be signed by the contractor and given to the Engineer at the end of each produced lot. The Engineer will calculate the quantity required in the area represented by the lot using the mix design weight per cubic foot. This calculation will be compared to the actual quantity placed.

A lot will be considered to be acceptable, with a zero pay factor, if the actual spread quantity varies by no more than -2.0 to +5.0 percent from the required quantity.

If the quantity in a lot is found to vary between -2.0 and -12.0 percent, pay factors will be determined in accordance with Table 416-2. These pay factors will be utilized in the pay adjustment as outlined in Subsection 416-9.

416-7.04 Gradation, Asphalt Cement Content, Effective Voids and Stability:

A lot shall be considered to be one shift's production; however, production consisting of less than one shift, such as at the beginning or at the completion of production will also be considered to be a lot. If changes are made in the mix design, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 75 pounds. The Engineer will split the sample and save one half for 15 days. The material will be tested by the Engineer for asphalt cement content, gradation, Marshall density and stability, and maximum theoretical density. Asphalt cement content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace. Marshall density and stability, and maximum theoretical density shall be tested in accordance with the requirements of Arizona Test Method 416. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424, Section 2.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, invoice weights, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration be performed. If a difference of greater than 0.1 percent is determined between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, a correction to the asphalt cement value determined by ignition furnace testing shall be made. The correction, once documented and approved by the Engineer, may be applied to test results from up to and including the fifth day of asphaltic concrete production. The resulting correction factor shall be applied thence forward. For other plants, no correction will be made to asphalt cement content values measured by ignition furnace.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after the time samples were obtained for the lot, the contractor may make a written request for additional testing of that lot. The additional testing shall be performed in an independent approved laboratory designated by the Engineer. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for Marshall density and stability, and maximum theoretical density in accordance with the requirements of Arizona

Test Method 416. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424, Section 2. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt cement content by ignition furnace and gradation of the mineral aggregate. New PT's will be determined for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified above. The results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

A mixture-properties lot placed with an average stability below 2,500 pounds for base mixes, or 1,750 pounds for 1/2 or 3/4 inch mixes shall be rejected, and shall be subject to an engineering analysis of anticipated performance in accordance with Subsection 416-9(E). Production shall cease until the contractor proposes a corrective action the Engineer finds acceptable. If the Engineer rejects the proposed corrective action, the contractor shall submit a revised mix design.

The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Measured Characteristics	LL	UL
Gradation (Sieve size):		
3/8 inch (Note 2)	TV - 6.0	TV + 6.0
No. 8	TV - 6.0	TV + 6.0
No. 40	TV - 5.0	TV + 5.0
No. 200	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.4	TV + 1.0
Notes:		
1) The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the applicable target value (TV).		
2) In the case of the 3/8 inch sieve requirement, for the base mix only, the lower limit shall be the target value minus 8.0, and the upper limit shall be the target value plus 8.0.		

The Engineer will determine the PT of each measured characteristic using the procedure defined under "Definitions, Abbreviations and Formulas for Acceptance". Utilizing Table 416-2, the Engineer will then determine pay factors for each measured characteristic.

416-7.05 Compaction:

(A) Courses 1-1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 degrees F. Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 degrees F.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic-tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic-tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than five pounds per square inch from the designated pressure. Pneumatic-tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic-tired compactors shall be equipped with skirt-type devices mounted around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No.1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2- 4*
Finish	Static Steel	Static Steel	1-3	1-3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic-tired compactors are used, will designate the tire pressure.

One pneumatic-tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 degrees F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 degrees F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverages of the compactors as specified.

(B) Courses Greater than 1-1/2 Inches in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractors responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A lot for compaction purposes shall be identical to the lot described in Subsection 416-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 416-9(D). Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate ten random locations within the lot, and the contractor shall take two cores at each location. The Engineer will save one core from each location for 15 working days after written notification to the contractor of test results for the lot. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest one foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. If rumble strips are formed by rolling indentations into the compacted pavement, the area of the pavement surface from one foot inside of the traffic lane edge of a rumble strip to the outside edge of a shoulder will be excluded from testing, and material in that area will not be included in the compaction lot quantity; however, if rumble strips are placed in the compacted pavement by grinding, sawing, or milling, that area will not be excluded from testing, and material in that area will be included in the compaction lot quantity. Areas excluded from testing will be compacted in accordance with Subsection 416-705(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be

taken not later than two working days after the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the contractor within five working days of receipt of cores by the Engineer. In trench areas where more than one lift is placed, coring shall be accomplished through the full depth after the final lift is placed. The compaction density shall be based on the ten cores, each the full depth of the trench.

The target value shall be 98.0 percent of laboratory density. The laboratory density will be the average of the four laboratory densities determined in Subsection 416-7.04.

The Upper Limit (UL) is the Target Value (TV) plus 4.0 pounds per cubic foot and the Lower Limit (LL) is the Target Value (TV) minus 4.0 pounds per cubic foot. The Engineer will determine the PT for compaction using the procedure defined under "Definitions, Abbreviations and Formulas for Acceptance", and, utilizing Table 416-2, will determine the compaction pay factor.

In the event the contractor elects to question the core test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for the lot has been made, the contractor may make a written request for additional testing of that lot. The cores previously saved will be tested in accordance with the requirements of Arizona Test Method 415 in an independent testing laboratory designated by the Engineer. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, the test results by the Department, or the density target. Using the referee test results, the Engineer will determine new PT's for the compaction characteristic. The result of this determination will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the compaction pay factor of the lot does not improve, is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

416-7.06 Smoothness:

The final asphaltic concrete surface will be tested by the Engineer. The finished surface shall not vary more than 1/8 inch from the lower edge of a ten foot straightedge when the straightedge is placed in the longitudinal direction, or 1/4 inch when placed in the transverse direction across longitudinal joints. All deviations exceeding the specified tolerance shall be corrected by the contractor.

416-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement and any necessary mineral admixture. Measurement will include any quantity used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 416-7.04 for each lot of asphaltic concrete

accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results, unless a correction was made to the ignition furnace test value as specified in Subsection 416-7.04, in which case no adjustment will be allowed.

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 416-6.

416-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot," a "mixture-properties lot," and a "compaction lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor.

The Engineer may exclude asphaltic concrete from spread lots if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots. The Engineer may exclude certain locations from the random sampling used in determining the mixture-properties lot pay factor and/or the compaction lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 416-7.03. If the quantity in a spread lot is found to vary by more than + 5.0 percent, no payment will be made for the material which exceeds the + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent, the spread lot will be rejected.

(B) Mixture-Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 416-7.04.
- (2) A single pay factor shall be for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.

- (3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed \$3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 416-9(E) shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 416-7.05(B).

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture-properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

- (1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 416-7.03.
- (2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random samples taken and tested in accordance with Subsection 416-7.04, regardless of which project(s) the samples fall within.
- (3) PT values and pay factors for compaction, for those areas subject to Subsection 416-7.05(B), shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that Subsection.
- (4) The mixture-properties lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(B), utilizing the individual pay factors determined in (2) above.
- (5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 416-9(C), utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within ten working days after receiving notice that a spread lot, mixture properties lot, or a compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$1.00 per ton for spread lots, and a minus \$3.00 per ton each for mixture properties lots and compaction lots. Positive mixture pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place.

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected lot is submitted for referee testing by the contractor, the ten working days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factors, and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

- (1) The occurrence of two or more rejected lots within any 10 concurrent lots.
- (2) The occurrence of three or more consecutive penalty lots.
- (3) The occurrence of five or more penalty and/or rejected lots within any 10 consecutive lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 416-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design, or the course of action proposed in the engineering analysis, shall be implemented, and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

(G) Mineral Admixture:

If mineral admixture is used in the mix design it will be paid for at the predetermined price established in the Bidding Schedule. If mineral admixture is eliminated, it will be eliminated in accordance with the requirements of Subsection 109.05; however, no reimbursement will be made for any costs which the contractor may have incurred in anticipation of its use.

DEFINITIONS, ABBREVIATIONS AND FORMULAS FOR ACCEPTANCE

Target Value (TV):

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design.

Average (AVE):

The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean. The average will be determined to one decimal place, except for asphalt cement content, which will be determined to two decimal places.

Standard Deviation (s):

The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE, divided by the number of test results minus one. This statement does not limit the methods of calculations of standard deviation; other methods which obtain the same value may be used. The standard deviation will be determined to two decimal places.

Upper Limit (UL):

The value above the TV of each measured characteristic which defines the upper limit of acceptable production.

Lower Limit (LL):

The value below the TV of each measured characteristic which defines the lower limit of acceptable production.

Upper Quality Index (QU):

$$QU = \frac{UL - AVE}{s}$$

The QU will be calculated to three decimal places.

Lower Quality Index (QL):

$$Q L = \frac{A V E - L L}{s}$$

The QL will be calculated to three decimal places.

Percentage of Lot Within UL (PU):

Determined by entering Table 416-1a (for N = 4) or Table 416-1b (for N = 10) with QU.

Percentage of Lot Within LL (PL):

Determined by entering Table 416-1a (for N = 4) or Table 416-1b (for N = 10) with QL.

Total Percentage of Lot Within UL and LL (PT):

$$P T = (P U + P L) - 100$$

Pay Factor(PF):

Determined by entering Table 416-2 with PT.

TABLE 416-1a DETERMINATION OF PU or PL Number of Tests "N" = 4			
QU or QL	PU or PL	QU or QL	PU or PL
1.485 or More	100	0.000 to - 0.014	50
1.455 to 1.484	99	- 0.015 to - 0.044	49
1.425 to 1.454	98	- 0.045 to - 0.074	48
1.395 to 1.424	97	- 0.075 to - 0.104	47
1.365 to 1.394	96	- 0.105 to - 0.134	46
1.335 to 1.364	95	- 0.135 to - 0.164	45
1.305 to 1.334	94	- 0.165 to - 0.194	44
1.275 to 1.304	93	- 0.195 to - 0.224	43
1.245 to 1.274	92	- 0.225 to - 0.254	42
1.215 to 1.244	91	- 0.255 to - 0.284	41
1.185 to 1.214	90	- 0.285 to - 0.314	40
1.155 to 1.184	89	- 0.315 to - 0.344	39
1.125 to 1.154	88	- 0.345 to - 0.374	38
1.095 to 1.124	87	- 0.375 to - 0.404	37
1.065 to 1.094	86	- 0.405 to - 0.434	36
1.035 to 1.064	85	- 0.435 to - 0.464	35
1.005 to 1.034	84	- 0.465 to - 0.494	34
0.975 to 1.004	83	- 0.495 to - 0.524	33
0.945 to 0.974	82	- 0.525 to - 0.554	32
0.915 to 0.944	81	- 0.555 to - 0.584	31
0.885 to 0.914	80	- 0.585 to - 0.614	30
0.855 to 0.884	79	- 0.615 to - 0.644	29

TABLE 416-1a DETERMINATION OF PU or PL Number of Tests "N" = 4			
QU or QL	PU or PL	QU or QL	PU or PL
0.825 to 0.854	78	- 0.645 to - 0.674	28
0.795 to 0.824	77	- 0.675 to - 0.704	27
0.765 to 0.794	76	- 0.705 to - 0.734	26
0.735 to 0.764	75	- 0.735 to - 0.764	25
0.705 to 0.734	74	- 0.765 to - 0.794	24
0.675 to 0.704	73	- 0.795 to - 0.824	23
0.645 to 0.674	72	- 0.825 to - 0.854	22
0.615 to 0.644	71	- 0.855 to - 0.884	21
0.585 to 0.614	70	- 0.885 to - 0.914	20
0.555 to 0.584	69	- 0.915 to - 0.944	19
0.525 to 0.554	68	- 0.945 to - 0.974	18
0.495 to 0.524	67	- 0.975 to - 1.004	17
0.465 to 0.494	66	- 1.005 to - 1.034	16
0.435 to 0.464	65	- 1.035 to - 1.064	15
0.405 to 0.434	64	- 1.065 to - 1.094	14
0.375 to 0.404	63	- 1.095 to - 1.124	13
0.345 to 0.374	62	- 1.125 to - 1.154	12
0.315 to 0.344	61	- 1.155 to - 1.184	11
0.285 to 0.314	60	- 1.185 to - 1.214	10
0.255 to 0.284	59	- 1.215 to - 1.244	9
0.225 to 0.254	58	- 1.245 to - 1.274	8
0.195 to 0.224	57	- 1.275 to - 1.304	7
0.165 to 0.194	56	- 1.305 to - 1.334	6
0.135 to 0.164	55	- 1.335 to - 1.364	5
0.105 to 0.134	54	- 1.365 to - 1.394	4
0.075 to 0.104	53	- 1.395 to - 1.424	3
0.045 to 0.074	52	- 1.425 to - 1.454	2
0.015 to 0.044	51	- 1.455 to - 1.484	1
0.000 to 0.014	50	- 1.485 or Less	0

TABLE 416-1b DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
2.176 or More	100	0.000 to - 0.012	50
1.940 to 2.175	99	- 0.013 to - 0.038	49
1.798 to 1.939	98	- 0.039 to - 0.064	48
1.691 to 1.797	97	- 0.065 to - 0.090	47
1.603 to 1.690	96	- 0.091 to - 0.116	46
1.526 to 1.602	95	- 0.117 to - 0.142	45
1.458 to 1.525	94	- 0.143 to - 0.169	44

TABLE 416-1b
DETERMINATION OF PU or PL
Number of Tests "N" = 10

QU or QL	PU or PL	QU or QL	PU or PL
1.396 to 1.457	93	- 0.170 to - 0.195	43
1.339 to 1.395	92	- 0.196 to - 0.222	42
1.286 to 1.338	91	- 0.223 to - 0.248	41
1.236 to 1.285	90	- 0.249 to - 0.275	40
1.188 to 1.235	89	- 0.276 to - 0.302	39
1.143 to 1.187	88	- 0.303 to - 0.329	38
1.100 to 1.142	87	- 0.330 to - 0.356	37
1.058 to 1.099	86	- 0.357 to - 0.383	36
1.018 to 1.057	85	- 0.384 to - 0.411	35
0.980 to 1.017	84	- 0.412 to - 0.439	34
0.942 to 0.979	83	- 0.440 to - 0.467	33
0.906 to 0.941	82	- 0.468 to - 0.495	32
0.871 to 0.905	81	- 0.496 to - 0.524	31
0.836 to 0.870	80	- 0.525 to - 0.553	30
0.802 to 0.835	79	- 0.554 to - 0.582	29
0.769 to 0.801	78	- 0.583 to - 0.612	28
0.737 to 0.768	77	- 0.613 to - 0.642	27
0.705 to 0.736	76	- 0.643 to - 0.673	26
0.674 to 0.704	75	- 0.674 to - 0.704	25
0.643 to 0.673	74	- 0.705 to - 0.736	24
0.613 to 0.642	73	- 0.737 to - 0.768	23
0.583 to 0.612	72	- 0.769 to - 0.801	22
0.554 to 0.582	71	- 0.802 to - 0.835	21
0.525 to 0.553	70	- 0.836 to - 0.870	20
0.496 to 0.524	69	- 0.871 to - 0.905	19
0.468 to 0.495	68	- 0.906 to - 0.941	18
0.440 to 0.467	67	- 0.942 to - 0.979	17
0.412 to 0.439	66	- 0.980 to - 1.017	16
0.384 to 0.411	65	- 1.018 to - 1.057	15
0.357 to 0.383	64	- 1.058 to - 1.099	14
0.330 to 0.356	63	- 1.100 to - 1.142	13
0.303 to 0.329	62	- 1.143 to - 1.187	12
0.276 to 0.302	61	- 1.188 to - 1.235	11
0.249 to 0.275	60	- 1.236 to - 1.285	10
0.223 to 0.248	59	- 1.286 to - 1.338	9
0.196 to 0.222	58	- 1.339 to - 1.395	8
0.170 to 0.195	57	- 1.396 to - 1.457	7
0.143 to 0.169	56	- 1.458 to - 1.525	6
0.117 to 0.142	55	- 1.526 to - 1.602	5
0.091 to 0.116	54	- 1.603 to - 1.690	4
0.065 to 0.090	53	- 1.691 to - 1.797	3
0.039 to 0.064	52	- 1.798 to - 1.939	2

TABLE 416-1b DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
0.013 to 0.038	51	- 1.940 to - 2.175	1
0.000 to 0.012	50	- 2.176 or Less	0

TABLE 416-2 PAY FACTORS					
Material Spread		Mixture Properties and Compaction			
Negative Variance %	Pay Factor \$ / ton	PT	Pay Factors: \$ / ton		
			Gradation and Asphalt Content	Effective Voids	Compaction
2.1 - 3.0	- 0.10	100	0.00	+ 1.00	+ 1.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 0.50	+ 0.50
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.30
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50	- 1.75
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00	- 2.25
		50 - 54	- 2.50	- 2.50	- 3.00

SECTION 417 ASPHALTIC CONCRETE (END PRODUCT) SHRP VOLUMETRIC MIX:

417-1 Description:

The work under this section shall consist of furnishing all materials, mixing at a plant, hauling and placing a mixture of aggregate materials, mineral admixture if required, and an asphalt cement to form a pavement course or to be used for other specified purposes, in accordance with the details shown on the project plans and the requirements of these specifications.

It is the intent of this specification that the contractor acquire and make all arrangements for a source or sources of material; furnish Certificates of Compliance as hereinafter specified; furnish a mix design which will meet the design criteria specified hereinafter; and provide all the equipment, materials, and labor necessary to furnish and place the asphaltic concrete in accordance with the requirements specified herein.

The type of asphaltic concrete mix shall be specified in the Special Provisions.

417-2 Asphaltic Concrete Mix Design Criteria:

Mix designs shall be developed by the contractor. Each mix design shall meet the criteria in Table 417-1 and the grading requirements in Table 417-2 when tested in accordance with Arizona Test Method 815 with the noted exceptions.

TABLE 417-1 ASPHALTIC CONCRETE MIX DESIGN CRITERIA				
Criteria	Requirements			
	1/2" Mix	3/4" Mix	1" Mix	1-1/2" Mix
Voids in Mineral Aggregate: %, Minimum	14.5	13.5	12.5	11.5
Effective Voids: %, Range	As specified in Special Provisions			
Absorbed Asphalt: %, Range	0 - 1.0 (All mixes)			
Index of Retained Strength: % (Arizona Test Method 802)	60 Minimum (All mixes) (See Note 7 below)			
Wet Strength: psi (Arizona Test Method 802)	150 Minimum (All mixes)			
Notes:				
1. Mix design laboratory compacted test specimens, except for Arizona Test Method 802, shall be prepared using a gyratory compactor in accordance with AASHTO Provisional Standard TP-4.				
2. The mix design shall be formulated in a manner described for Level 1 mix designs in The Superpave Mix Design Manual for New Construction and Overlays (SHRP-A-407) except that volumetrics will be determined in accordance with Arizona Test Method 815, and number of trial blend gradations necessary will be determined by the mix design laboratory. Duplicate gyratory samples shall be prepared at a minimum of 3 binder contents to select the recommended binder content. The completed mix design shall meet all the mineral aggregate and mix design criteria specified herein.				
3. The ratio of the mix design composite gradation target for the No. 200 sieve, including admixture, to the effective asphalt content shall be as specified in the Special Provisions.				
4. Arizona Test Method 802 specimens shall be prepared by replacing the plus 3/4 inch material of the composite with material passing the 3/4 inch sieve and retained on the 1/2 inch sieve size fraction during mineral aggregate sample weigh up.				
5. For purposes of design, the number of gyrations shall be as specified in the Special Provisions. The corrected density of the specimens shall be less than 89.0 percent of maximum theoretical density at the number of gyrations specified in the Special Provisions. The corrected density of the specimens shall be less than 98.0 percent of maximum theoretical density at the number of gyrations specified in the Special Provisions.				
6. Oven aging period for mix design gyratory samples shall be 2 hours.				

TABLE 417-1 ASPHALTIC CONCRETE MIX DESIGN CRITERIA	
7.	For interstate roadways, if the average elevation of the project is above 3500 feet, the Index of Retained Strength shall be a minimum of 70 percent.

TABLE 417-2 MIX DESIGN GRADING LIMITS FOR 1-1/2 INCH MIX		
	Coarse Band	Fine Band
	(Passing Below the Restricted Zone)	(Passing Through or Above Restricted Zone)
	Mineral Aggregate without admixture	
Sieve Size	Percent Passing	
2 inch	100	100
1-1/2 inch	90 - 100	90 - 100
1 inch	40 - 89	52 - 89
No. 4	15 - 35	36 - 89
No. 8	15 - 23	24 - 41
No. 16	0 - 16	17 - 41
No. 30	0 - 12	13 - 41
No. 50	0 - 10	10 - 41
No. 200	0 - 4.0	0 - 4.0

TABLE 417-2 (Continued) MIX DESIGN GRADING LIMITS FOR 1 INCH MIX		
	Coarse Band	Fine Band
	(Passing Below the Restricted Zone)	(Passing Through or Above Restricted Zone)
	Mineral Aggregate without admixture	
Sieve Size	Percent Passing	
1-1/2 inch	100	100
1 inch	90 - 100	90 - 100
3/4 inch	44 - 89	56 - 89
No. 4	19 - 40	41 - 89
No. 8	19 - 27	28 - 45
No. 16	1 - 18	19 - 45
No. 30	1 - 14	15 - 45
No. 50	1 - 11	12 - 45
No. 200	1.0 - 4.5	1.0 - 4.5

TABLE 417-2 (Continued) MIX DESIGN GRADING LIMITS FOR 3/4 INCH MIX		
	Coarse Band	Fine Band
	(Passing Below the Restricted Zone)	(Passing Through or Above Restricted Zone)
	Mineral Aggregate without admixture	
Sieve Size	Percent Passing	

TABLE 417-2 (Continued) MIX DESIGN GRADING LIMITS FOR 3/4 INCH MIX		
1 inch	100	100
3/4 inch	90 - 100	90 - 100
1/2 inch	43 - 89	60 - 89
No. 8	23 - 35	36 - 49
No. 16	2 - 22	23 - 49
No. 30	2 - 17	18 - 49
No. 50	2 - 14	15 - 49
No. 200	2.0 - 5.0	2.0 - 5.0

TABLE 417-2 (Continued) MIX DESIGN GRADING LIMITS FOR 1/2 INCH MIX		
	Coarse Band	Fine Band
	(Passing Below the Restricted Zone)	(Passing Through or Above Restricted Zone)
	Mineral Aggregate without admixture	
Sieve Size	Percent Passing	
3/4 inch	100	100
1/2 inch	90 - 100	90 - 100
3/8 inch	53 - 89	64 - 89
No. 8	28 - 39	40 - 52
No. 16	2 - 25	26 - 52
No. 30	2 - 19	20 - 52
No. 50	2 - 16	17 - 52
No. 200	2.0 - 5.5	2.0 - 5.5

TABLE 417-2 (Continued) MIX DESIGN GRADING LIMITS	
Notes:	
(1)	The contractor may provide a mix meeting the Fine Band or Coarse Band mix design grading limits unless otherwise specified.
(2)	In addition to the mineral aggregate grading requirements, the contractor's mix design shall provide a minimum of 25 percent intermediate size mineral aggregate for the 1/2" mix, 20 percent for the 3/4" mix, and 15 percent for the 1" and 1-1/2" mixes. Intermediate size mineral aggregate is defined as the percentage of mineral aggregate passing the 3/8" sieve and retained on the No. 8 sieve in the combined mineral aggregate, exclusive of mineral admixture.

417-3 Materials:

417-3.01 Mineral Aggregate:

The contractor shall provide a source of material in conformance with the requirements of Section 1001 of these specifications. Sub-paragraph (3) regarding sampling and testing under Subsection 1001- 4(B) is hereby deleted.

Coarse mineral aggregate shall consist of crushed gravel, crushed rock, or other approved inert material with similar characteristics, or a combination thereof, conforming to the requirements of these specifications.

Fine mineral aggregate shall be obtained from crushed gravel or crushed rock. All uncrushed material passing the No. 4 sieve shall be removed prior to the crushing, screening, and washing operations necessary to produce the specified gradation. The contractor shall notify the Engineer a minimum of 48 hours in advance of crushing the material to be used as mineral aggregate, so all crushing operations can be inspected. Existing stockpile material which has not been inspected during crushing will not be permitted for use unless the contractor is able to document to the Engineer's satisfaction that the mineral aggregate has been crushed. Any material inspected by the Department as crushed material shall be separated from the contractor's other stockpiles and reserved for use throughout the project duration.

The contractor may blend uncrushed fine aggregate up to a maximum of 15 percent of the total aggregate for mixes meeting the fine band grading requirements or up to a maximum of 10 percent of the total aggregate for mixes meeting the coarse band grading requirements, provided that the composite of uncrushed fine aggregate and crushed fine aggregate meets the requirement for uncompacted void content. The uncrushed fine aggregate shall be 100 percent passing the 1/4 inch sieve and contain not more than 4.0 percent passing the No. 200 sieve. Should the contractor modify the method of producing either the uncrushed or crushed fine aggregate, the Engineer shall be immediately notified and the materials sampled and tested for determination of uncompacted void content.

Aggregates shall be free of deleterious materials, clay balls, and adhering films or other material that prevent the thorough coating with the asphalt cement.

Mineral aggregate shall conform to the following requirements when tested in accordance with the applicable test methods:

Mineral Aggregate Characteristics	Test Method	Requirement
Combined Bulk Specific Gravity	Arizona Test Methods 210 & 211	2.35 - 2.85
Combined Water Absorption	Arizona Test Methods 210 & 211	0 - 2.5%
Sand Equivalent	AASHTO T 176	Minimum 55
Abrasion	AASHTO T 96	100 Rev., Max 9% 500 Rev., Max 40%
Fractured Coarse Aggregate Particles	Arizona Test Method 212	Minimum 85% with at least two fractured faces (plus No. 4 material)
Flat and Elongated Particles	ASTM D 4791 (except test shall be performed on plus No. 4 material)	Maximum 10% (of the plus No. 4 material) 5:1

Mineral Aggregate Characteristics	Test Method	Requirement
Uncompacted Void Content	Arizona Test Method 247	As specified in the Special Provisions

Tests on aggregates outlined above, except for abrasion, shall be performed on materials furnished for mix design purposes and composited to the mix design gradation. Abrasion shall be performed separately on materials from each source of mineral aggregate. All sources shall meet the requirements for abrasion.

Mineral aggregate from a source or combination of sources which does not meet the requirements, according to the contractor's mix design proposal, for combined bulk specific gravity and/or combined water absorption up to a maximum of 3.0 percent, but which meets other specified requirements, will be further considered for acceptance by the Engineer if: (a) the total estimated cost of all asphaltic concrete components, using the mix design unit weight, asphalt cement content, and mineral admixture percentage, does not exceed the total amount bid for these items by more than 5.0 percent; or (b) a supplemental agreement is executed adjusting the unit prices of asphaltic concrete components such that the total estimated cost does not exceed the total amount bid by more than 5.0 percent.

417-3.02 Mineral Admixture:

When the mix design includes a mineral admixture, the amount used shall be 1.0 percent, by weight of the mineral aggregate, unless testing demonstrates that additional admixture is required in order to meet the mix design criteria for index of retained strength. A maximum of 2.0 percent admixture will be permitted. The exact amount of admixture required shall be specified in the mix design. Mineral admixture shall be either portland cement, blended hydraulic cement, or hydrated lime conforming to the following requirements:

Material	Requirement
Portland Cement, Type I or II	ASTM C 150
Blended Hydraulic Cement, Type IP	ASTM C 595
Hydrated Lime	ASTM C 1097

A Certificate of Analysis conforming to the requirements of Subsection 106.05 of the Standard Specification shall be submitted to the Engineer.

417-3.03 Bituminous Material:

Asphalt cement shall be a performance grade (PG) asphalt binder conforming to the requirements of Section 1005. The type of asphalt binder shall be as shown in the Special Provisions.

The contractor shall provide the laboratory mixing and compaction temperature ranges to the mix design laboratory for each PG asphalt binder used for mix design purposes. The laboratory mixing temperature range is defined as the range of temperatures where the un-aged asphalt binder has a rotational viscosity 0.17 ± 0.02 pascal-seconds, measured in accordance with ASTM D 4402. The laboratory compaction temperature range is defined

as the range of temperatures where the un-aged asphalt binder has a rotational viscosity 0.28 ± 0.03 pascal-seconds, measured in accordance with ASTM D 4402. The testing required in ASTM D 4402 shall be performed at 275 °F and 350 °F, and a viscosity-temperature curve developed in accordance with ASTM D 2493. The viscosity-temperature curve shall be included in the mix design report. For PG asphalt binders that have a maximum laboratory mixing temperature exceeding 325 °F or a maximum laboratory compaction temperature exceeding 300 °F, the laboratory mixing and compaction temperature ranges shall be specified by the asphalt binder supplier. The laboratory mixing and compaction temperature ranges shall be reported on the mix design. The contractor shall ensure that the asphalt binder supplier information required in this paragraph is provided to all appropriate parties in a timely manner, and that copies are included in the mix design report.

417-4 Mix Design:

Utilizing mineral aggregate which has been crushed, processed, separated, and stockpiled, a mix design shall be formulated and submitted by the contractor to the Engineer. The mineral aggregate samples used for mix design purposes shall be representative of aggregate materials to be used during production.

The mix design shall be based on the mix design criteria and other requirements hereinbefore specified, utilizing asphalt cement and mineral admixture of the type and from the sources proposed for use in the production of asphaltic concrete. The mix design shall be prepared under the direct supervision of a professional engineer experienced in the development of mix designs and mix design testing.

The mix design shall be prepared by a mix design laboratory that has met the requirements of the Department's "System for the Evaluation of Testing Laboratories". The requirements may be obtained from ADOT Materials Group, 1221 North 21st Avenue, Phoenix, Arizona 85009-3740.

The use of a mix design developed for a previous project which meets these specifications may be proposed by the contractor provided the methods of producing mineral aggregate have not changed since the development of the mix design, the asphalt cement and mineral admixture type and source of supply have not changed, the mix design test values meet all current specification requirements, and the previous use of the mix design was satisfactory to the Department. The Engineer will determine whether a previously used mix design can be approved for use based upon the evidence provided by the contractor of current stockpile gradations, fractured coarse aggregate particles and sand equivalent, and the evidence provided by the contractor that the results obtained during production under the previously used mix design were satisfactory. Should the Engineer question the evidence provided or determine the previous use was not satisfactory, the contractor shall prepare and submit a new mix design in accordance with these specifications.

The mix design shall contain as a minimum:

- (1) The name and address of the testing organization and the person responsible for the mix design testing.

- (2) The specific location(s) of the source(s) of mineral aggregate.
- (3) The supplier, refinery, type of asphalt cement and any modifiers including polymers, the source and type of mineral admixture, and the percentage of asphalt cement and mineral admixture to be used.
- (4) The anticipated mineral aggregate gradation in each stockpile.
- (5) Mix design gradation and mix test results from all trial gradations. The mix design shall contain the mineral aggregate gradation, and also the gradation with mineral admixture if it is utilized.
- (6) The results of all testing, determinations, etc., such as: specific gravity of each component, water absorption, sand equivalent, loss on abrasion, fractured coarse aggregate particles, flat and elongated particles, uncompacted void content, immersion compression results (Index of Retained Strength, wet and dry strengths), asphalt absorption, percent air voids, voids in mineral aggregate, and bulk density. Historical abrasion values may be supplied on existing sources.
- (7) Viscosity-temperature curve along with the laboratory mixing and compaction temperature ranges.

The mix design shall be submitted in a format which clearly provides all the mix design requirements and be signed by a person authorized by the contractor to act in such matters on the contractor's behalf.

The mix design and representative samples of the mineral aggregate used in the mix design shall be submitted to the Engineer for calibration of the ignition furnace, and the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content at least two working days prior to the start of asphaltic concrete production. Collection of the samples provided by the contractor shall be witnessed by the Engineer, and the samples shall be representative of the materials produced. The sand equivalent will be determined in accordance with the requirements of AASHTO T 176, the fractured coarse aggregate particles (plus No. 4 material with at least 2 fractured faces) in accordance with Arizona Test Method 212, and the uncompacted void content in accordance with Arizona Test Method 247. The sand equivalent determined by the Engineer must be at least 90 percent and not more than 110 percent of the value contained in the contractor's mix design, and meet the minimum requirements specified in Subsection 417-3.01. The fractured coarse aggregate particles and uncompacted void content determined by the Engineer shall meet the minimum requirements specified in Subsection 417-3.01. If the mineral aggregate fails to meet these requirements, asphaltic concrete production shall not commence, and the contractor shall either submit a revised mix design which is representative of the materials produced or correct the deficiencies in the aggregate stockpiles.

The Engineer will review the mix design to assure that it contains all required information. If it does not, it will be returned within two working days of receipt of all samples and mix design information for further action and resubmission by the contractor.

If the contractor elects to change its source of material, the contractor shall furnish the Engineer with a new mix design which meets the requirements specified hereinbefore.

The contractor may make self-directed target changes to the approved mix design within the limits shown below. Requests for self-directed target changes shall be made in writing and acknowledged by the Engineer prior to start of production for a lot. The self-directed target changes must meet contract requirements for mix design criteria and grading limits.

MEASURED CHARACTERISTICS	ALLOWABLE SELF-DIRECTED TARGET CHANGES
Gradation (sieve size): 3/4 Inch 3/8 Inch No. 8 No. 30 No. 200	$\pm 2\%$ from the mix design target value $\pm 2\%$ from the mix design target value $\pm 2\%$ from the mix design target value $\pm 1\%$ from the mix design target value None
Asphalt Cement Content	$\pm 0.2\%$ from the mix design target value
Effective Voids	None

The contractor may propose target changes to the approved mix design for the Engineer's approval. The Engineer will determine if the proposed target change will result in mix production that meets the contract requirements for mix design criteria and grading limits. For acceptance purposes, target changes will not be retroactive.

Should a mix design prove unsatisfactory to the contractor during production, the contractor shall furnish the Engineer with a revised mix design. For acceptance purposes, the revised mix design will not be retroactive.

417-5 Contractor Quality Control:

The contractor shall perform the quality control measures described in the Special Provisions.

417-6 Construction Requirements:

The contractor shall be responsible for the proportioning of all materials, for the hauling, placing, loading, spreading and finishing of asphaltic concrete, and for the applying of bituminous material, such as tack coats, prime coats and provisional seals, all in accordance with the appropriate portions of the specifications.

Mixing plants shall conform to the requirements of AASHTO M 156 except as modified herein.

The temperature of asphaltic concrete upon discharge from the mixer shall not exceed 325 °F unless a higher temperature is recommended by the asphalt cement supplier and approved by the Engineer. A recording pyrometer or other approved thermometric instrument sensitive to a rate of temperature change not less than 10 °F per minute shall be placed at the discharge chute of the drier so as to automatically record the temperature of the asphaltic concrete or mineral aggregate. A copy of the recording shall be delivered to the Engineer at the end of each shift of production.

If a mineral admixture is necessary to produce asphaltic concrete that meets the design criteria, the mineral admixture shall be mechanically mixed with the mineral aggregate prior to combining the mineral aggregate and asphalt cement. The Engineer may direct a spray of water be applied either to control the loss of the mineral admixture or to comply with any mix design requirements for wet mixing of aggregate and admixture.

If a conventional drum mix plant is used, the mineral admixture shall be added and thoroughly mixed by means of a mechanical mixing device prior to the mixture entering the drum drier. The moisture content of the combined mineral aggregate shall be a minimum of three percent by weight of the aggregate during the mixing process. The mineral admixture shall be weighed across a weigh belt, or an approved alternative weighing system, with a weight totalizer prior to entry into the mechanical mixing device. The mechanical mixing device shall be a pugmill type mixer consisting of at least two motorized shafts with mixing paddles. The mixing device shall be designed such that the mixture of aggregate and admixture is moved in a near horizontal direction by the mixing paddles without the aid of conveyor belts for a distance of at least three feet. Mixing devices which permit the aggregate to fall through mixing blades onto a belt or chute are not acceptable. The mixing device's rated capacity in tons per hour shall not be exceeded by the rate of aggregate feed to the mixer. The mixer shall be constructed to prevent the leakage of the contents. The mixer shall be located in the aggregate delivery system at a location where the mixed material can be readily inspected on a belt prior to entry into the drum. The mixing device shall be capable of effective mixing in the full range of asphaltic concrete production rates.

If a batch plant is used, the mineral admixture shall be added and thoroughly mixed in the pugmill prior to adding asphalt cement. The system by which mineral admixture is incorporated into the production of asphaltic concrete at the pugmill shall be designed to minimize the loss of the mineral admixture.

The contractor's plant and equipment shall be capable of introducing admixture into the asphaltic concrete without significant loss of mineral admixture through the dust collection system of the plant. The method of introducing admixture into plant types other than a conventional drum mix or batch plant is subject to the approval of the Engineer.

The contractor shall furnish daily documentation to the Engineer that the required amount of mineral admixture has been incorporated into the asphaltic concrete.

If a mineral admixture is used, a positive signal system and a limit switch device shall be installed in the plant at the point of introduction of the admixture. The positive signal system shall be placed between the metering device and the drum dryer, and utilized during

production whereby the mixing shall automatically be stopped if the admixture is not being introduced into the mixture.

All courses of asphaltic concrete shall be placed and finished by means of self-propelled paving machines except under certain conditions or at certain locations where the Engineer deems the use of self-propelled paving machines impractical.

Pavers shall be equipped with an activated screed for the full width being paved, heated if necessary, and capable of spreading and finishing all courses of asphaltic concrete.

Pavers shall be equipped with automatic screed controls with sensors for either or both sides of the paver, capable of sensing grade from an outside reference line, sensing the transverse slope of the screed, and providing the automatic signals which operate the screed to maintain the desired grade and transverse slope.

Failure of the control system to function properly shall be cause for the suspension of the placing of asphaltic concrete.

The base or subgrade upon which asphaltic concrete is to be placed shall be prepared and maintained in a firm condition until asphaltic concrete is placed. It shall not be frozen or excessively wet.

At any time the Engineer may require the work to cease or that the work day be reduced in the event of weather conditions, either existing or expected, which would have an adverse effect upon the asphaltic concrete.

All wheels and tires of compactors and other equipment surfaces shall be wiped when necessary with a product approved by the Engineer in order to prevent the sticking of asphaltic concrete.

Before asphaltic concrete is placed, the surface to be paved shall be cleaned of objectionable material.

Longitudinal joints of each course shall be staggered a minimum of one foot with relation to the longitudinal joint of any immediate underlying course.

When surfacing courses are placed on ten foot or wider shoulders which are to receive rumble strips, the contractor shall place any longitudinal joints approximately one foot away from the travel lane side of the rumble strip.

Longitudinal joints shall be located within one foot of the center of a lane or within one foot of the centerline between two adjacent lanes. Joints shall be formed by a slope shoe or hot-lapped, and shall result in an even, uniform surface.

Before a surface course is placed in contact with a cold transverse construction joint, the cold existing asphaltic concrete shall be trimmed to a vertical face by cutting the existing asphaltic concrete back for its full depth of the lift and exposing a fresh face. After placement and finishing of the new asphaltic concrete, both sides of the joint shall be dense

and the joint shall be well sealed. The surface in the area of the joint shall conform to the requirements hereinafter specified for surface tolerances when tested with the straightedge placed across the joint.

All locations where plate samples are taken from the roadway shall be immediately repaired by the contractor utilizing hot asphaltic concrete. All holes where cores are taken shall be repaired within 48 hours after coring using a material approved by the Engineer. All holes shall be in a dry condition prior to repair. The patching material shall be thoroughly compacted in the holes by the contractor.

The handling of asphaltic concrete shall at all times be such as to minimize segregation. Any asphaltic concrete which displays segregation shall be removed and replaced.

A light coat of bituminous material shall be applied as directed to edges or vertical surfaces against which asphaltic concrete is to be placed.

The contractor shall schedule its paving operations to minimize exposed longitudinal edges. Unless otherwise approved by the Engineer, the contractor shall limit the placement of asphaltic concrete courses, in advance of adjacent courses, to one shift of asphaltic concrete production. The contractor shall schedule its paving operations in such a manner to eliminate exposed longitudinal edges over weekends or holidays.

The moisture content of the asphaltic concrete immediately behind the paver shall not exceed 0.5 percent. The moisture content will be determined in accordance with Arizona Test Method 406. Drying and heating shall be accomplished in such a manner as to preclude the mineral aggregate from becoming coated with fuel oil or carbon.

417-7 Acceptance:

417-7.01 General:

In addition to the random acceptance samples taken from each lot, the Engineer may sample and reject material which appears to be defective. Such rejected material shall not be used in the work. The results of tests run on rejected material will not be included with the lot acceptance tests.

Acceptance will be on the basis of the following:

- Sand Equivalent
- Fractured Coarse Aggregate Particles
- Uncompacted Void Content
- Material Spread
- Gradation
- Asphalt Cement Content
- Effective Voids
- Compaction
- Smoothness

417-7.02 Sand Equivalent, Fractured Coarse Aggregate Particles, and Uncompacted Void Content of Mineral Aggregate:

During asphaltic concrete production, the Engineer shall obtain and test samples of mineral aggregate for the determination of the sand equivalent, fractured coarse aggregate particles, and uncompacted void content. The sample shall be obtained either from the cold feed belt prior to the addition of mineral admixture if used, or from the stockpiles. The sand equivalent will be determined by the Engineer in accordance with the requirements of AASHTO T 176, the fractured coarse aggregate particles (plus No. 4 material with at least 2 fractured faces) in accordance with Arizona Test Method 212, and the uncompacted void content in accordance with Arizona Test Method 247. Mineral aggregate will be acceptable for sand equivalent when the running average of three sand equivalent tests is at least 90 percent and no single test is less than 80 percent of the sand equivalent result contained in the contractor's mix design. Mineral aggregate shall meet the minimum requirements for fractured coarse aggregate particles and uncompacted void content specified in Subsection 417-3.01. If the mineral aggregate fails to meet these requirements, operations shall cease and the contractor shall have the option of submitting a revised mix design conforming to the requirements of Subsection 417-4 or correcting deficiencies in the aggregate stockpiles.

417-7.03 Material Spread:

A spread lot shall be considered to be one-half shift of production. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9(D). Information pertaining to each lot shall be recorded by the contractor on forms provided by the Engineer.

Information recorded shall include the project number, date each spread lot was placed, the spread lot number, beginning and ending station, the plans thickness and tons placed in each lot. The form shall be signed by the contractor and given to the Engineer at the end of each produced lot. The Engineer will calculate the quantity required in the area represented by the lot using the mix design weight per cubic foot. This calculation will be compared to the actual quantity placed.

A lot will be considered to be acceptable, with a zero pay factor, if the actual spread quantity varies by no more than - 2.0 to + 5.0 percent from the required quantity.

If the quantity in a lot is found to vary between - 2.0 and - 12.0 percent, pay factors will be determined in accordance with Table 417-4. These pay factors will be utilized in the pay adjustment as outlined in Subsection 417-9.

417-7.04 Gradation, Asphalt Cement Content, and Effective Voids:

A lot shall be considered to be one shift's production; however, production consisting of less than one shift, such as at the beginning or at the completion of production, will also be considered to be a lot. If changes are made in the mix design, new lots will be established.

Four samples of the asphaltic concrete shall be taken for each lot by the contractor, under the observation of the Engineer, at random locations designated by the Engineer. Samples shall be taken in accordance with the requirements of Section 2 or 3 of Arizona Test Method 104 and delivered to the Engineer immediately after being taken. The minimum weight of the sample shall be 130 pounds. The Engineer will split the sample and save one-half for 15 days. The material will be tested by the Engineer for asphalt cement content, gradation, gyratory density, and maximum theoretical density. Gyratory density and maximum theoretical density shall be tested in accordance with the requirements of Arizona Test Method 416. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424, Section 2. Arizona Test Methods 416 and 424 are modified to replace references to Marshall testing with Gyratory testing in accordance with AASHTO Provisional Standard TP-4. Asphalt cement content and gradation shall be tested in accordance with Arizona Test Method 427 using an ignition furnace.

For plants providing asphaltic concrete exclusively for this project, the difference between the asphalt cement content as measured by ignition furnace testing and the actual asphalt cement content shall be determined. If approved by the Engineer, a plant may be considered exclusive to the project if an asphalt cement tank is dedicated for the shift of asphaltic concrete production. The determination of the actual asphalt cement content may include weighing of asphalt cement deliveries, invoice weights, volumetric tank measurements using a calibrated rod (tank stickings) corrected for temperature, computerized mass-flow meter, and accounting for wasted materials. If a computerized mass-flow meter is used, documentation of its calibration shall be submitted to the Engineer prior to asphaltic concrete production. At any time during asphaltic concrete production, the Engineer may require that a new calibration be performed. If there is a difference of greater than 0.1 percent asphalt cement content between the asphalt cement content measured by ignition furnace testing and the actual asphalt cement content, a correction to the asphalt cement content by ignition furnace testing shall be made. The correction, once documented and approved by the Engineer, may be applied to test results from up to and including the fifth day of asphaltic concrete production. The resulting correction factor shall be applied thence forward. For other plants, no correction will be made to asphalt cement content values measured by ignition furnace.

Acceptance testing results will be furnished to the contractor within four working days of receipt of samples by the Engineer.

In the event the contractor elects to question the test results obtained for a particular lot, within 15 days after the time samples were obtained for that lot, the contractor may make a written request for additional testing of that lot. The additional testing shall be performed in an independent approved laboratory designated by the Engineer. The testing of the samples will be performed by the independent testing laboratory without knowledge of the specific project conditions such as the identity of the contractor or mix design laboratory, the tests results by the Department, or the mix design targets for gradation and effective voids. The asphaltic concrete samples previously saved will be tested for gyratory density and maximum theoretical density in accordance with the requirements of Arizona Test Method 416. Effective voids will be determined in accordance with the requirements of Arizona Test Method 424, Section 2. Arizona Test Methods 416 and 424 are modified to replace references to Marshall testing with Gyratory testing in accordance with AASHTO

Provisional Standard TP-4. The samples shall also be tested in accordance with Arizona Test Method 427 for asphalt cement content by ignition furnace and gradation of the mineral aggregate. New PT's will be determined for all characteristics, with the exception of asphalt cement content if a correction to the ignition furnace value was made as specified above. The results of these determinations will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the total pay factor of the lot does not improve or is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

The Upper Limits (UL) and Lower Limits (LL) of acceptable production of each of the measured characteristics are as follows:

Coarse Band 1-1/2" and 1" Mixes		
Measured Characteristics	LL	UL
Gradation		
3/4" sieve	TV - 8.0	TV + 8.0
3/8" sieve	TV - 8.0	TV + 8.0
No. 8 sieve	TV - 5.0	TV + 5.0
No. 200 Sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV -0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5

Fine Band 1-1/2" and 1" Mixes		
Measured Characteristics	LL	UL
Gradation		
3/4" sieve	TV - 8.0	TV + 8.0
3/8" sieve	TV - 8.0	TV + 8.0
No. 8 sieve	TV - 6.0	TV + 6.0
No. 200 Sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5

Coarse Band 3/4" and 1/2" Mixes		
Measured Characteristics	LL	UL
Gradation		
3/8" sieve	TV - 8.0	TV + 8.0
No. 8 sieve	TV - 5.0	TV + 5.0
No. 30 sieve	TV - 5.0	TV + 5.0
No. 200 sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5

Fine Band 3/4" and 1/2" Mixes		
Measured Characteristics	LL	UL
Gradation		
3/8" sieve	TV - 6.0	TV + 6.0
No. 8 sieve	TV - 6.0	TV + 6.0

Fine Band 3/4" and 1/2" Mixes		
Measured Characteristics	LL	UL
No. 30 sieve	TV - 5.0	TV + 5.0
No. 200 sieve	TV - 2.0	TV + 2.0
Asphalt Cement Content	TV - 0.50	TV + 0.50
Effective Voids	TV - 2.0	TV + 1.5

Note: The limits are used in the statistical calculations for Quality Index. Acceptance is controlled by the variability of the produced material and every effort should be made to strive for the center of the applicable Target Value (TV).

The Engineer will determine the PT of each measured characteristic using the procedure defined under "Definitions, Abbreviations, and Formulas for Acceptance". Utilizing Table 417-4, the Engineer will then determine pay factors for each measured characteristic.

417-7.05 Compaction:

(A) Courses 1-1/2 Inches or Less in Nominal Thickness:

(1) General Requirements:

Asphaltic concrete shall be placed only when the temperature of the surface on which the asphaltic concrete is to be placed is at least 65 °F. Asphaltic concrete immediately behind the laydown machine shall be a minimum of 250 °F.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

(2) Equipment:

Compacting and smoothing shall be accomplished by the use of self-propelled equipment. Compactors shall be pneumatic tired and/or steel wheel.

Compactors shall be operated in accordance with the manufacturer's recommendations. Compactors shall be designed and properly maintained so that they are capable of accomplishing the required compaction.

Steel wheel compactors shall weigh not less than eight tons.

Pneumatic tired compactors shall be the oscillating type with at least seven pneumatic tires of equal size and diameter. Wobble-wheel compactors will not be permitted. The tires shall be spaced so that the gaps between adjacent tires will be covered by the following tires. The tires shall be capable of being inflated to 90 pounds per square inch and maintained so that the air pressure will not vary more than 5 pounds per square inch from the designated pressure. Pneumatic tired compactors shall be constructed so that the total weight of the compactor will be varied to produce an operating weight per tire of not less than 5,000 pounds. Pneumatic tired compactors shall be equipped with skirt-type devices mounted

around the tires so that the temperature of the tires will be maintained during the compaction process.

(3) Rolling Method Procedure:

Compaction shall consist of an established sequence of coverage using specified types of compactors. A pass shall be defined as one movement of a compactor in either direction. Coverage shall be the number of passes as are necessary to cover the entire width being paved.

The rolling sequence, the type of compactor to be used, and the number of coverages required shall be as follows:

Rolling Sequence	Type of Compactor		No. of Coverages	
	Option No. 1	Option No. 2	Option No. 1	Option No. 2
Initial	Static Steel	Vibrating Steel	1	1
Intermediate	Pneumatic Tired	Vibrating Steel	4	2 - 4*
Finish	Static Steel	Static Steel	1 - 3	1 - 3
* Based on the roller pattern which exhibits the best performance.				

The Engineer shall select the option for compaction and, when pneumatic tired compactors are used, will designate the tire pressure.

One pneumatic tired roller shall be furnished for each 300 tons of asphaltic concrete per hour.

Steel wheel compactors shall not be used in the vibratory mode for courses of one inch or less in thickness nor when the temperature of the asphaltic concrete falls below 180 °F.

Initial and intermediate compaction shall be accomplished before the temperature of the asphaltic concrete falls below 200 °F.

Compaction will be deemed to be acceptable on the condition that the asphaltic concrete is compacted using the type of compactors specified, ballasted and operated as specified, and with the number of coverage's of the compactors as specified.

(B) Courses Greater than 1-1/2 Inches in Nominal Thickness:

Compaction control shall be the responsibility of the contractor. The number and types of rollers shall be the contractors responsibility and shall be sufficient to meet these requirements.

All edges shall be rolled with a pneumatic tired compactor, or other methods approved by the Engineer, while the mixture is still hot.

A lot for compaction purposes shall be identical to the lot described in Subsection 417-7.04. Lots encompassing more than one project shall be separated in accordance with Subsection 417-9(D). Each lot shall be tested for acceptance.

Twenty cores shall be taken for each lot by the contractor, under the observation of the Engineer. The Engineer will designate 10 random locations within the lot and the contractor shall take two cores at each location. The Engineer will save one core from each location for 15 working days after written notification to the contractor of test results for the lot. Randomly selected locations will be determined to the nearest one-half foot in the transverse direction and to the nearest foot in the longitudinal direction of the pavement course; however, the outside one foot of the unconfined pavement course will be excluded from testing. When a previously unconfined pavement course is confined by a subsequent pavement course, the compacted joint will not be excluded from the testing. If rumble strips are formed by rolling indentations into the compacted pavement, the area of the pavement surface from one foot inside of the traffic lane edge of a rumble strip to the outside edge of the shoulder will be excluded from testing, and material in that area will not be included in the compaction lot quantity; however, if rumble strips are placed in the compacted pavement by grinding, sawing, or milling, that area will not be excluded from testing, and material in that area will be included in the compaction lot quantity. Areas excluded from testing will be compacted in accordance with Subsection 417-7.05(A). Cores shall be taken utilizing mechanical coring equipment in accordance with the requirements of Arizona Test Method 104, Section 3. Cores shall be a minimum of four inches in diameter and shall be taken not later than two working days after the lot placement. The cores shall be delivered to the Engineer immediately upon being taken. The cores will be tested for acceptance by the Engineer in accordance with the requirements of Arizona Test Method 415. Acceptance testing results will be furnished to the contractor within five working days of receipt of cores by the Engineer. In trench areas where more than one lift is placed, coring shall be accomplished through the full depth after the final lift is placed. The compaction density shall be based on the 10 cores, each the full depth of the trench.

The target value shall be 7.0 percent in-place air voids. In-place air voids shall be determined using Arizona Test Method 424, Section 2. The maximum theoretical density used in determination of air voids will be the average of the four maximum theoretical densities determined in Subsection 417-7.04.

The Upper Limit (UL) is 9.0 percent in-place air voids and the Lower Limit (LL) is 4.0 percent in-place air voids. The Engineer will determine the PT for compaction using the procedure defined under "Definitions, Abbreviations, and Formulas for Acceptance", and utilizing Table 417-4, will determine the compaction pay factor.

In the event the contractor elects to question the core test results obtained for a particular lot, within 15 days after written notification to the contractor of test results for that lot has been made, the contractor may make a written request for additional testing of that lot. The cores previously saved will be tested in accordance with the requirements of Arizona Test Method 415 in an independent testing laboratory designated by the Engineer. The testing of the cores will be performed by the independent testing laboratory without knowledge of the specific project conditions, such as the identity of the contractor or mix design laboratory, or the test results by the Department. Using the referee test results, the

Engineer will determine new PT's for the compaction characteristic. The result of this determination will be binding on both the contractor and the Department. The Department will pay for this testing; however, if the compaction pay factor of the lot does not improve, is reduced, or the lot remains in reject, payment to the contractor for asphaltic concrete shall be reduced by the amount of the cost of this testing.

417-7.06 Smoothness:

The final asphaltic concrete surface will be tested by the Engineer. The finished surface shall not vary more than 1/8 inch from the lower edge of a ten foot straightedge when the straightedge is placed in the longitudinal direction, or 1/4 inch when placed in the transverse direction across longitudinal joints. All deviations exceeding the specified tolerance shall be corrected by the contractor.

417-8 Method of Measurement:

Asphaltic concrete will be measured by the ton for the asphaltic concrete actually used, which will include the weight of mineral aggregate, asphalt cement, and any necessary mineral admixture. Measurement will include any weight used in construction of intersections, turnouts, or other miscellaneous items or surfaces.

Asphalt cement will be measured by the ton on the basis of the asphalt cement content determined in accordance with Subsection 417-7.04 for each lot of asphaltic concrete accepted. The average asphalt cement content will be multiplied by the number of tons of asphaltic concrete in that lot to determine the amount of asphalt cement. If the contractor has requested referee testing, the average asphalt cement content will come from the independent testing laboratory results, unless a correction was made to the ignition furnace test value as specified in Subsection 417-7.04, in which case no adjustment will be allowed.

Mineral admixture will be measured by the ton for the mineral admixture actually used in accordance with Subsection 417-6.

417-9 Basis of Payment:

The accepted quantities of asphaltic concrete, measured as provided above, will be paid for at the contract unit price adjusted by the appropriate total pay factor as hereinafter provided.

For the purpose of determining acceptability and appropriate total pay factors, each unit of asphaltic concrete will be included in three separate lots: a "spread lot," a "mixture properties lot," and a "compaction lot." The total unit price for any unit of accepted asphaltic concrete will be the contract unit price, adjusted by the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor.

The Engineer may exclude asphaltic concrete from spread lots if the Engineer determines that the proposed use of the material or the existing surface conditions are not conducive to the use of spread lots. The Engineer may exclude certain locations from the random sampling used in determining the mixture properties lot pay factor, and/or the compaction

lot pay factor should the Engineer determine that the location of the work precludes normal construction operations.

(A) Spread Lot Pay Factor:

The spread lot pay factor will be determined in accordance with Subsection 417-7.03. If the quantity in a spread lot is found to vary by more than + 5.0 percent, no payment will be made for the material which exceeds the + 5.0 percent, including asphalt cement and mineral admixture. If the quantity is found to vary by more than - 12.0 percent, the spread lot will be rejected.

(B) Mixture Properties Lot Pay Factor:

The mixture properties lot pay factor shall be determined in accordance with the following procedure:

- (1) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids shall be determined as set forth in Subsection 417-7.04.
- (2) A single pay factor shall be determined for Gradation and Asphalt Cement Content. That pay factor shall be the lowest pay factor for the individual measured characteristics for Gradation and Asphalt Cement Content.
- (3) If no individual PT value in (1) above is less than 50, the mixture properties lot pay factor shall be the sum of the pay factor determined in (2) above and the Effective Voids pay factor. The negative pay factor for mixture properties shall not exceed \$3.00 per ton. If any individual PT value is less than 50, the lot is in reject and the provisions in Subsection 417-9(E) shall apply.

(C) Compaction Lot Pay Factor:

The compaction lot pay factor shall be the compaction pay factor determined as set forth in Subsection 417-7.05(B).

(D) Determination of Lot Pay Factors on Contracts Involving Multiple Projects:

When more than one project is included in a single contract, placement during a shift or half shift of production may encompass more than one project. In such case, the applicable spread lot pay factor, mixture properties lot pay factor, and compaction lot pay factor for each project shall be determined as follows:

- (1) Spread lot pay factors will be determined separately for each project utilizing the procedure set forth in Subsection 417-7.03.
- (2) The individual PT values and pay factors for Gradation, Asphalt Cement Content, and Effective Voids will be determined from the results of the random

samples taken and tested in accordance with Subsection 417-7.04, regardless of which project(s) the samples fall within.

- (3) PT values and pay factors for compaction, for those areas subject to Subsection 417-7.05(B), shall be determined from separate sets of core samples for each project utilizing the procedure set forth in that Subsection.
- (4) The mixture properties lot pay factor shall be determined separately for each project in accordance with Subsection 417-9(B), utilizing the individual pay factors determined in (2) above.
- (5) The compaction lot pay factor shall be determined separately for each project in accordance with Subsection 417-9(C), utilizing the pay factor determined in (3) above.

(E) Acceptability:

Asphaltic concrete included in any mixture properties lot possessing an individual PT value lower than 50 for Gradation, Asphalt Cement Content, or Effective Voids will be rejected. Asphaltic concrete included in any compaction lot possessing a PT value lower than 50 will be rejected.

Within ten working days after receiving notice that a spread lot, mixture properties lot, or compaction lot of asphaltic concrete has been rejected by the Engineer, the contractor may submit a written proposal to accept the material in place at the applicable maximum negative pay factor(s). Maximum negative pay factors are defined as a minus \$1.00 per ton for spread lots; and a minus \$3.00 per ton each for mixture properties lots and compaction lots. Positive mixture lot pay factors become zero when the compaction lot is in reject and the material is allowed to be left in place.

The proposal shall contain an engineering analysis of the anticipated performance of the asphaltic concrete if left in place. The engineering analysis shall also detail any proposed corrective action, and the anticipated effect of such corrective action on the performance. The engineering analysis shall be performed by a professional engineer experienced in asphaltic concrete testing and the development of asphaltic concrete mix designs. If a rejected lot is submitted for referee testing by the contractor, the ten working days allowed to prepare an engineering analysis will begin upon notification of referee test results.

Within three working days, the Engineer will determine whether or not to accept the contractor's proposal. If the proposal is not accepted, the asphaltic concrete shall be removed at no additional cost to the Department and replaced with asphaltic concrete meeting the requirements of these specifications. If the proposal is accepted, the asphaltic concrete shall remain in place at the applicable maximum negative pay factors, and any necessary corrective action shall be performed at no additional cost to the Department.

The Department reserves the right to suspend the work should any of the following conditions occur:

- (1) The occurrence of two or more rejected lots within any ten concurrent lots.
- (2) The occurrence of three or more consecutive penalty lots.
- (3) The occurrence of five or more penalty and/or rejected lots within any ten consecutive lots.

If the Department elects to suspend the work for any of these conditions, the contractor shall either submit a revised mix design in accordance with Subsection 417-4, or submit for the Engineer's approval a written engineering analysis. The engineering analysis shall detail the course of action necessary to correct deficiencies in the contractor's present production methods such that further production can be accomplished without excessive amounts of asphaltic concrete in penalty or rejection. If approved by the Engineer, the revised mix design or the course of action proposed in the engineering analysis, shall be implemented and the work may continue. Costs or delays due to the provisions of this subsection are not compensable.

(F) Asphalt Cement:

Payment for asphalt cement will be made by the ton. Adjustments in payment shall be made in accordance with the requirements of Subsection 1005-3.01.

(G) Mineral Admixture:

If mineral admixture is used in the mix design, it will be paid for at the predetermined price established in the Bidding Schedule. If mineral admixture is eliminated, it will be eliminated in accordance with the requirements of Subsection 109.05; however, no reimbursement will be made for any costs which the contractor may have incurred in anticipation of its use.

DEFINITIONS, ABBREVIATIONS AND FORMULAS FOR ACCEPTANCE

Target Value (TV):

The target values for gradation, asphalt cement content, and effective voids are given in the contractor's mix design.

Average (AVE):

The sum of the lot's test results for a measured characteristic divided by the number of test results; the arithmetic mean. The average will be determined to one decimal place, except for asphalt cement content, which will be determined to two decimal places.

Standard Deviation (s):

The square root of the value formed by summing the squared difference between the individual test results of a measured characteristic and AVE, divided by the number of test results minus one. This statement does not limit the methods of calculations of standard

deviation; other methods which obtain the same value may be used. The standard deviation will be determined to two decimal places.

Upper Limit (UL):

The value above the TV of each measured characteristic which defines the upper limit of acceptable production.

Lower Limit (LL):

The value below the TV of each measured characteristic which defines the lower limit of acceptable production.

Upper Quality Index (QU):

$$QU = \frac{UL - AVE}{s}$$

The QU will be calculated to three decimal places.

Lower Quality Index (QL):

$$QL = \frac{AVE - LL}{s}$$

The QL will be calculated to three decimal places.

Percentage of Lot Within UL (PU):

Determined by entering Table 417-3a (for N = 4) or Table 417-3b (for N = 10) with QU.

Percentage of Lot Within LL (PL):

Determined by entering Table 417-3a (for N = 4) or Table 417-3b (for N = 10) with QL.

Total Percentage of Lot Within UL and LL (PT):

$$PT = (PU + PL) - 100$$

Pay Factor (PF):

Determined by entering Table 417-4 with PT.

TABLE 417-3a DETERMINATION OF PU or PL Number of Tests "N" = 4			
QU or QL	PU or PL	QU or QL	PU or PL

TABLE 417-3a
DETERMINATION OF PU or PL
Number of Tests "N" = 4

QU or QL	PU or PL	QU or QL	PU or PL
1.485 or More	100	0.000 to -0.014	50
1.455 to 1.484	99	-0.015 to -0.044	49
1.425 to 1.454	98	-0.045 to -0.074	48
1.395 to 1.424	97	-0.075 to -0.104	47
1.365 to 1.394	96	-0.105 to -0.134	46
1.335 to 1.364	95	-0.135 to -0.164	45
1.305 to 1.334	94	-0.165 to -0.194	44
1.275 to 1.304	93	-0.195 to -0.224	43
1.245 to 1.274	92	-0.225 to -0.254	42
1.215 to 1.244	91	-0.255 to -0.284	41
1.185 to 1.214	90	-0.285 to -0.314	40
1.155 to 1.184	89	-0.315 to -0.344	39
1.125 to 1.154	88	-0.345 to -0.374	38
1.095 to 1.124	87	-0.375 to -0.404	37
1.065 to 1.094	86	-0.405 to -0.434	36
1.035 to 1.064	85	-0.435 to -0.464	35
1.005 to 1.034	84	-0.465 to -0.494	34
0.975 to 1.004	83	-0.495 to -0.524	33
0.945 to 0.974	82	-0.525 to -0.554	32
0.915 to 0.944	81	-0.555 to -0.584	31
0.885 to 0.914	80	-0.585 to -0.614	30
0.855 to 0.884	79	-0.615 to -0.644	29
0.825 to 0.854	78	-0.645 to -0.674	28
0.795 to 0.824	77	-0.675 to -0.704	27
0.765 to 0.794	76	-0.705 to -0.734	26
0.735 to 0.764	75	-0.735 to -0.764	25
0.705 to 0.734	74	-0.765 to -0.794	24
0.675 to 0.704	73	-0.795 to -0.824	23
0.645 to 0.674	72	-0.825 to -0.854	22
0.615 to 0.644	71	-0.855 to -0.884	21
0.585 to 0.614	70	-0.885 to -0.914	20
0.555 to 0.584	69	-0.915 to -0.944	19
0.525 to 0.554	68	-0.945 to -0.974	18
0.495 to 0.524	67	-0.975 to -1.004	17
0.465 to 0.494	66	-1.005 to -1.034	16
0.435 to 0.464	65	-1.035 to -1.064	15
0.405 to 0.434	64	-1.065 to -1.094	14
0.375 to 0.404	63	-1.095 to -1.124	13
0.345 to 0.374	62	-1.125 to -1.154	12
0.315 to 0.344	61	-1.155 to -1.184	11
0.285 to 0.314	60	-1.185 to -1.214	10
0.255 to 0.284	59	-1.215 to -1.244	9

TABLE 417-3a DETERMINATION OF PU or PL Number of Tests "N" = 4			
QU or QL	PU or PL	QU or QL	PU or PL
0.225 to 0.254	58	-1.245 to -1.274	8
0.195 to 0.224	57	-1.275 to -1.304	7
0.165 to 0.194	56	-1.305 to -1.334	6
0.135 to 0.164	55	-1.335 to -1.364	5
0.105 to 0.134	54	-1.365 to -1.394	4
0.075 to 0.104	53	-1.395 to -1.424	3
0.045 to 0.074	52	-1.425 to -1.454	2
0.015 to 0.044	51	-1.455 to -1.484	1
0.000 to 0.014	50	-1.485 or Less	0

TABLE 417-3b DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
2.176 or More	100	0.000 to -0.012	50
1.940 to 2.175	99	-0.013 to -0.038	49
1.798 to 1.939	98	-0.039 to -0.064	48
1.691 to 1.797	97	-0.065 to -0.090	47
1.603 to 1.690	96	-0.091 to -0.116	46
1.526 to 1.602	95	-0.117 to -0.142	45
1.458 to 1.525	94	-0.143 to -0.169	44
1.396 to 1.457	93	-0.170 to -0.195	43
1.339 to 1.395	92	-0.196 to -0.222	42
1.286 to 1.338	91	-0.223 to -0.248	41
1.236 to 1.285	90	-0.249 to -0.275	40
1.188 to 1.235	89	-0.276 to -0.302	39
1.143 to 1.187	88	-0.303 to -0.329	38
1.100 to 1.142	87	-0.330 to -0.356	37
1.058 to 1.099	86	-0.357 to -0.383	36
1.018 to 1.057	85	-0.384 to -0.411	35
0.980 to 1.017	84	-0.412 to -0.439	34
0.942 to 0.979	83	-0.440 to -0.467	33
0.906 to 0.941	82	-0.468 to -0.495	32
0.871 to 0.905	81	-0.496 to -0.524	31
0.836 to 0.870	80	-0.525 to -0.553	30
0.802 to 0.835	79	-0.554 to -0.582	29
0.769 to 0.801	78	-0.583 to -0.612	28
0.737 to 0.768	77	-0.613 to -0.642	27
0.705 to 0.736	76	-0.643 to -0.673	26
0.674 to 0.704	75	-0.674 to -0.704	25
0.643 to 0.673	74	-0.705 to -0.736	24
0.613 to 0.642	73	-0.737 to -0.768	23

TABLE 417-3b DETERMINATION OF PU or PL Number of Tests "N" = 10			
QU or QL	PU or PL	QU or QL	PU or PL
0.583 to 0.612	72	-0.769 to -0.801	22
0.554 to 0.582	71	-0.802 to -0.835	21
0.525 to 0.553	70	-0.836 to -0.870	20
0.496 to 0.524	69	-0.871 to -0.905	19
0.468 to 0.495	68	-0.906 to -0.941	18
0.440 to 0.467	67	-0.942 to -0.979	17
0.412 to 0.439	66	-0.980 to -1.017	16
0.384 to 0.411	65	-1.018 to -1.057	15
0.357 to 0.383	64	-1.058 to -1.099	14
0.330 to 0.356	63	-1.100 to -1.142	13
0.303 to 0.329	62	-1.143 to -1.187	12
0.276 to 0.302	61	-1.188 to -1.235	11
0.249 to 0.275	60	-1.236 to -1.285	10
0.223 to 0.248	59	-1.286 to -1.338	9
0.196 to 0.222	58	-1.339 to -1.395	8
0.170 to 0.195	57	-1.396 to -1.457	7
0.143 to 0.169	56	-1.458 to -1.525	6
0.117 to 0.142	55	-1.526 to -1.602	5
0.091 to 0.116	54	-1.603 to -1.690	4
0.065 to 0.090	53	-1.691 to -1.797	3
0.039 to 0.064	52	-1.798 to -1.939	2
0.013 to 0.038	51	-1.940 to -2.175	1
0.000 to 0.012	50	-2.176 or Less	0

TABLE 417-4 PAY FACTORS					
Material Spread		Mixture Properties and Compaction			
Negative Variance%	Pay Factor \$/Ton	PT	Pay Factors: \$ / Ton		
			Gradation and Asphalt Content	Effective Voids	Compaction
2.1 - 3.0	- 0.10	100	0.00	+ 1.00	+ 1.00
3.1 - 4.0	- 0.20	95 - 99	0.00	+ 0.50	+ 0.50
4.1 - 5.0	- 0.30	90 - 94	0.00	0.00	0.00
5.1 - 6.0	- 0.40	85 - 89	0.00	- 0.25	- 0.25
6.1 - 7.0	- 0.50	80 - 84	- 0.25	- 0.50	- 0.50
7.1 - 8.0	- 0.60	75 - 79	- 0.50	- 0.75	- 0.75
8.1 - 9.0	- 0.70	70 - 74	- 0.75	- 1.00	- 1.00
9.1 - 10.0	- 0.80	65 - 69	- 1.00	- 1.25	- 1.30
10.1 - 11.0	- 0.90	60 - 64	- 1.50	- 1.50	- 1.75
11.1 - 12.0	- 1.00	55 - 59	- 2.00	- 2.00	- 2.25

		50 - 54	- 2.50	- 2.50	- 3.00
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